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MARINER R 1 AND 2

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Approved:

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SECTION I

MISSION DESCRIPTION

A. MISSION OBJECTIVES MARINER 1 (P-37) AND MARINER 2 (P-38)

The primary objective of the Mariner R Missions is to develop and launch two spacecraft to the near vicinity of the planet Venus in 1962. The primary objectives of the mission will be to receive communications from the spacecraft in the vicinity of Venus and to perform a radiometric temperature measurement of the planet. A secondary objective of the mission will be to make measurements of the interplanetary magnetic field and/or particle measurements in transit and in the vicinity of the planet.

The specific objectives of the Mariner R Missions are:

Engineering Objectives

1) Evaluation of the attitude control system.
2) Evaluation of the environmental control system.
3) Evaluation of the entire power system.
4) Evaluation of the communication system.

Scientific Objectives

1) Radiometer experiment.
2) Infrared experiment.
3) Magnetometer experiment.
4) Charged particles experiment.
5) Plasma experiment.
6) Micrometeorite experiment.

B. TRAJECTORY

Consideration of a single trajectory for engineering design, as representing the Cytherean Mission is inappropriate. One should think of the mission as being represented by a set of standard trajectories and dispersions.

A maximum firing period for the two Venus launchings is restricted by the maximum velocity or geocentric energy which the Mariner R spacecraft can achieve by utilizing the Atlas-Agena vehicle. In order to include all possible Mariner R launch days, a firing period of 67 days was utilized in the trajectory design.

On any given day, the capability exists for launching over a period of time. Unless compensated for, a delay in the launch time will cause an error at Venus encounter. This error increases as the delay becomes longer. The method to be used for compensation of the delay involves simultaneously altering the launch azimuth and the parking orbit coast time between the Agena burn periods. Southeast launchings are preferred on any given launch day in order to obtain maximum tracking from the Deep Space Instrumentation Facilities. Operational requirements associated with the launchings of the spacecraft require a minimum of 60 minutes firing window. Launch azimuths from 90° to 114° east of north are considered for the mission, and yield a 2.5 to 3.0 hour firing window.

The time of launch and the time from launch to geocentric injection will vary with launch azimuth at launch date. For a launch azimuth of 90° east of north, the longest time from launch to injection is approximately 35 minutes, taking into account all possible launch days. For a launch azimuth of 114° east of north, the shortest time from launch to injection is approximately 21 minutes.

Approximately 8 to 10 days after launch, heliocentric injection will occur. At this time the probe will commence to move primarily under the influence of the Sun in a near-elliptical orbit before aphelion. For the first 38 days of the firing period, the probe enters into its near elliptical orbit before aphelion, for the remainder of the firing period, heliocentric injection occurs after aphelion. If the Earth-Probe-Sun-Angle is less than 90°, the probe is outside the Earths orbit and a heliocentric injection time before aphelion is implied. If the angle is greater than 90°, the probe is within the Earth's orbit and a heliocentric injection time after aphelion is implied. The maximum Earth-Probe-Sun-Angle occurs some 25-35 days before Venus encounter. This maximum E-P-S-A value will probably not exceed 170°. The Earth-Probe distance at this time will vary from 16 to 28 million kilometers depending on the launch date. Flight time from launch to Venus encounter will vary from 150 days to 93 days as the launch date is delayed from the earliest to the latest launch date respectively. Thus the mission is designed such that the two spacecraft can be launched during the 67 days firing window. P-37 will be launched early in the window utilizing a slow trajectory and P-38 will follow at a later date utilizing a fast trajectory. The major constraint between the two is the time necessary on the launching pad to prepare P-38 for the mission. The Earth-Venus communication distance at arrival will also vary with launch date, as several arrival dates will be utilized.

The near Venus trajectory is approximately a hyperbola with respect to the target planet. The hyperbolic excess velocity varies from 5.5 km/sec to 6.0 km/sec depending on launch date. The probe approaches Venus from above the ecliptic plane and from behind (i.e., catching up with Venus in its orbit around the sun). It is desired that the trajectory pass through a point which lies on the line of intersection of Venus' orbital plane and a plane normal to the Venus-Sun line containing the center of Venus. The point is approximately 30,000 km from the center of Venus. This nominal aiming point corresponds to a range of closest approach distance of 20,000 to 30,000 km dependent on launch date. Because of midcourse guidance errors, actual trajectories may miss the nominal aiming point by 15,000 to 20,000 km. The mission is such that the arrival dates at Venus encounter for the two spacecraft will not be separated by more than 14 days or less than 3 days. Thus, at Cytherean distances the DSIF will have two spacecraft in view simultaneously. The trajectory is designed such that the probability that the unsterilized spacecraft will impact the planet Venus is less than .001 percent.

C. LAUNCH VEHICLES

The vehicle which will be used to launch the Mariner spacecraft will be a two-stage Atlas-Agena B (figure I-1). The vehicle first stage is an Atlas similar to the Convair Series D Research and Development vehicle. This stage consists of a three-section airframe powered by three liquid-propellant-engine subassemblies and uses a ground guidance system to provide trajectory control.

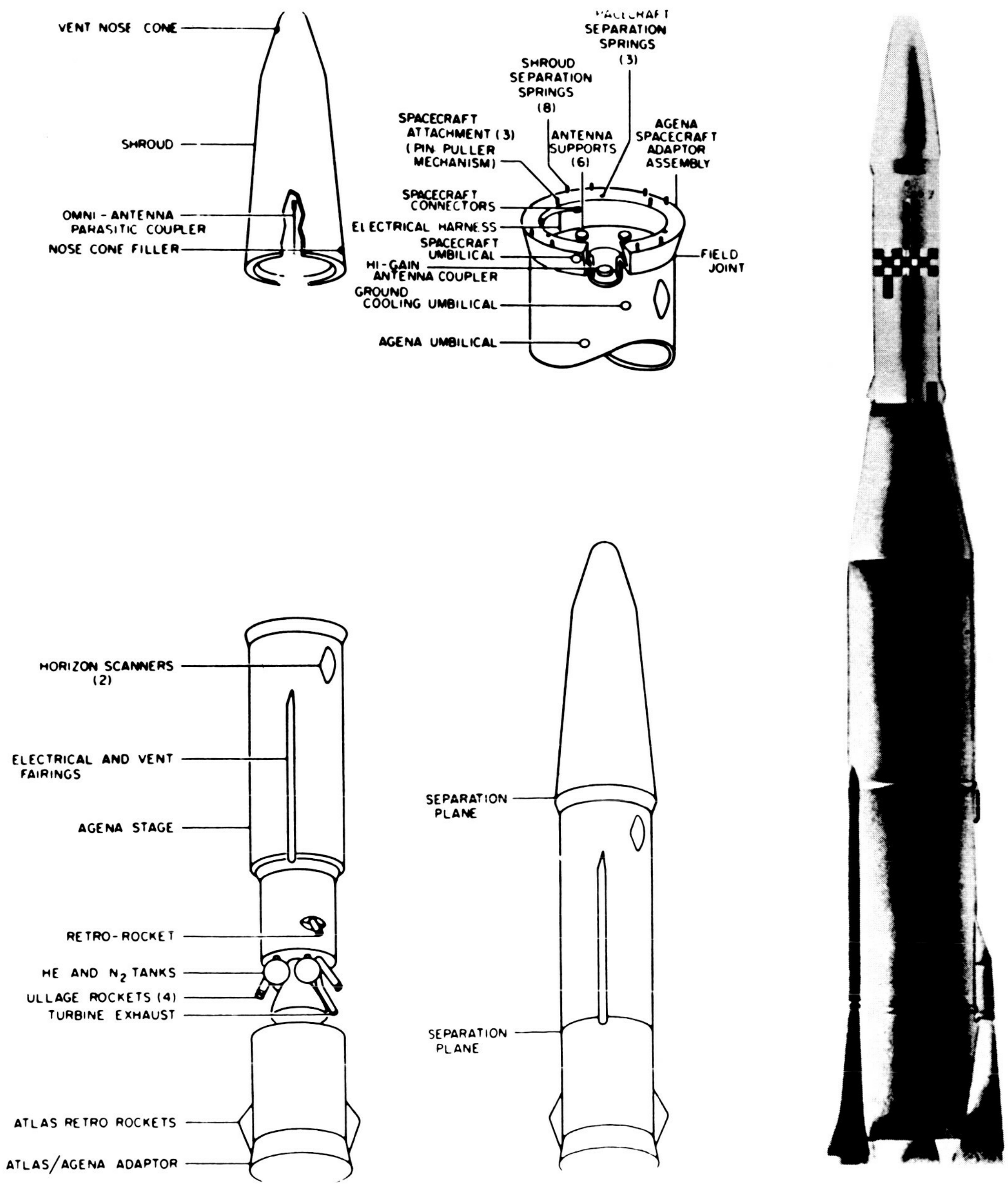

Figure I-1. Atlas-Agena B Launch Vehicle for Mariner R

The vehicle second stage consists of an airframe which houses and supports the second stage propellant and flight systems and the first stage and spacecraft adapters. The Agena B is powered by a liquid propellant engine with solid propellant motors used as retro and ullage rockets.

D. SPACECRAFT DESCRIPTION

The Mariner R spacecraft (Fig. I-2) employs many of the design principles and techniques developed on the Ranger program. This type of design resulted from the basic requirements of providing two-way communications with the spacecraft, performing planetary and interplanetary experiments, performing a midcourse maneuver to correct for miss components and time of arrival, and maintaining a reasonable thermal environment for the spacecraft.

Power for the spacecraft is obtained by converting the solar energy incident on solar cells into electrical energy. About 4900 cells are mounted on each of two 30 x 60 inch solar panels. These panels are moved to a position perpendicular to the roll axis shortly after Agena-Spacecraft separation. The raw power capability of the solar panels is about 200 watts at Earth and 175 watts at Venus. This solar cell performance degradation at Venus is due to a higher stabilized panel temperature and an expected damage by high-energy radiation during the flight.

A rechargeable battery of approximately 1000 watt-hour capacity will also be flown to share the peak power loads with the solar panels and to provide electrical energy for the spacecraft during periods when the spacecraft is not pointed at the sun. The spacecraft power subsystem supplies 50 volt, 2400 cps; 26 volt, 400 cps; and 25.8 to 33.3 volt, DC power to the various users. The 2400 cps power is the primary power used, with the 400 cps power used only for the gyros, the antenna hinge actuator, and the radiometer scan actuator. Battery power is used for such things as relay closures, pyrotechnic device activation and attitude control gas-jet-valve actuation.

The spacecraft will be stabilized in space by the attitude control subsystem. The roll axis is pointed at the sun to provide stability about the pitch

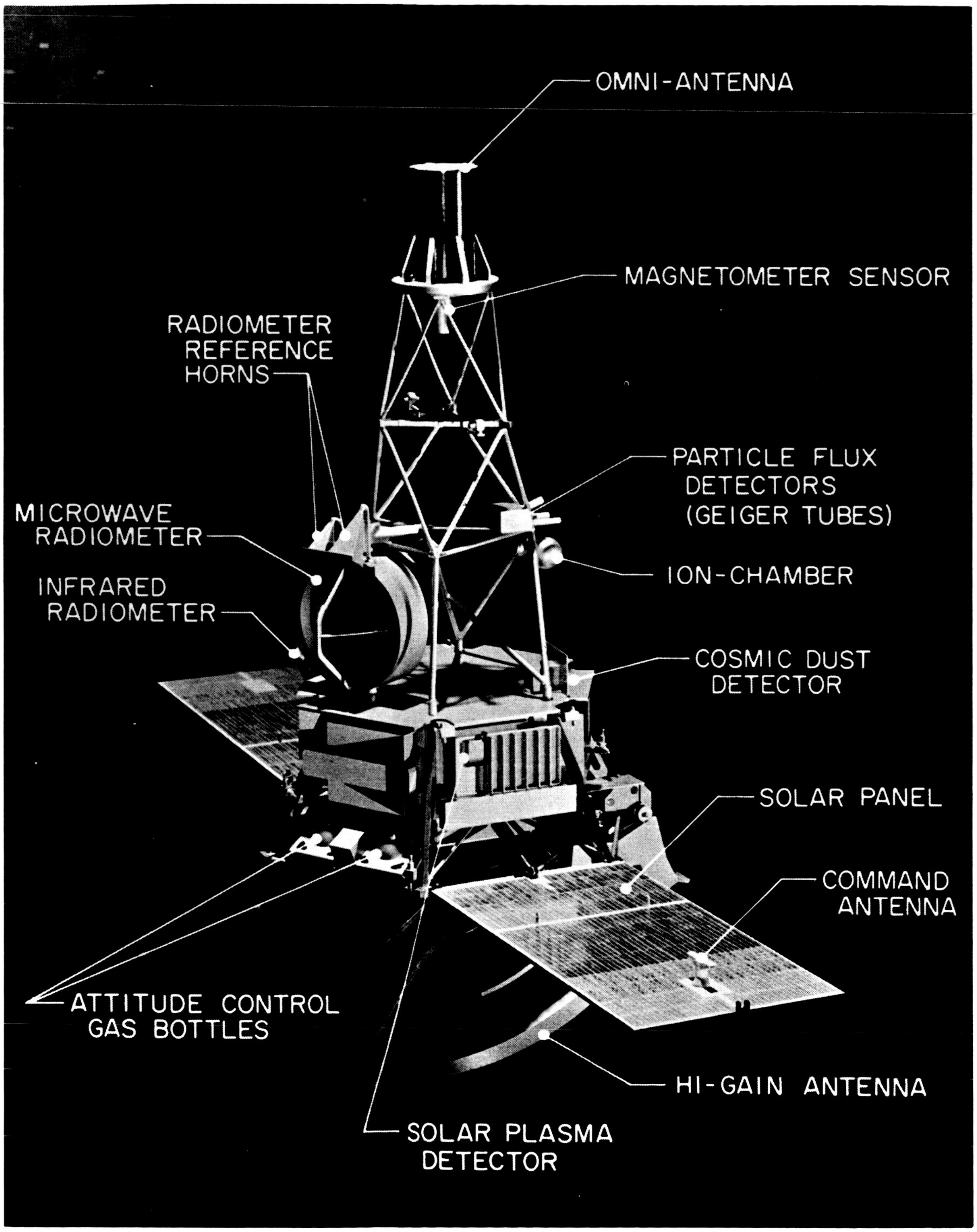

Figure I-2. Mariner R Spacecraft

and yaw axes. Roll stability is achieved by keeping the earth sensor, mounted on the directional antenna, pointing at the earth. Pointing the roll axis at the sun allows the maximum amount of solar energy to strike the solar panels and aids the thermal control of the spacecraft by maintaining the sun at a constant known attitude relative to the spacecraft. The pattern of the high gain antenna is very directive and consequently, must be pointed at the earth. This requirement is used to roll-stabilize the spacecraft, thus providing a stabilized platform for the science experiments. The sun and earth acquisitions are achieved through a series of sensors, gyros and internal logic circuits which cause actuation of cold-gas valves. Expulsion of gas in preferential directions provides desired rates about the various axes to bring the spacecraft into the desired stable attitude.

Pointing the spacecraft roll axis in a preferred direction for performance of the midcourse propulsion maneuver is another function of the attitude control system. The desired inertial attitude is attained by performing a roll turn and a pitch turn upon commands from the Central Computer and Sequencer (CC&S). During motor firing the autopilot portion of the attitude control subsystem maintains the thrust vector pointing through the spacecraft's center of gravity.

The CC&S is the subsystem that supplies timing,sequencing and computational services for other subsystems on the spacecraft. All events of the spacecraft are contained in one of three CC&S sequences. The launch sequence controls events which occur from launch through the cruise mode. The propulsion sequence controls the events necessary to perform the midcourse maneuver. All CC&S commands to be given in the vicinity of Venus are contained in the encounter sequence.

The launch sequence is always initiated at 3 minutes prior to liftoff. The propulsion sequence begins when the spacecraft receives a ground command to do so. Prior to this command, three other commands will have been sent to the spacecraft to indicate the magnitudes and direction of the required turns and the velocity increment to be applied during the propulsion sequence. The time for initiation of the encounter sequence is placed into the CC&S by a command through the umbilical during the launch countdown. All CC&S commands are inhibited until after spacecraft separation from the Agena.

Radio commands sent to the spacecraft are in the form of two modulated subcarrier signals. One of the subcarriers is modulated by a pseudo-noise sync code and the other subcarrier is modulated by command bits. The radio receiver recovers these signals and transmits them to the command subsystem. The command detector recovers the sync and command bits and applies them to the command decoder. The decoder determines which command has been sent and issues an output to the designated spacecraft subsystem.

Use of the real time commands permits updating of the antenna hinge reference, "unlocking" the earth sensor from some object other than the earth, switching of the RF signal from either the omni or directional antenna, initiating the propulsion sequence, turning on or off the planet science and changing the data rate back to 33 bits per second should it be lost during the launch. The stored commands are the polarity and magnitudes of the turns to be performed and the velocity increment to be applied in the midcourse maneuver.

The radio subsystem will be utilized to transmit an RF signal modulated with a composite telemetry signal and to receive RF commands transmitted by the DSIF. The transmitter will be operating at 960 mc and the receiver at 890 mc. From liftoff to spacecraft separation, the output from the transmitter will be about 1 watt. At separation the RF amplifier plate voltage will be increased from 150 volts to 250 volts; thus increasing the output from the transmitter to about 3 watts. Until 167 hours after launch the transmitted RF signal will radiate from the omniantenna. At this time the RF signal will be transferred to the directional antenna. This antenna will be used throughout the flight except during the midcourse maneuver at which time a ground command will cause the RF signal to be switched to the omniantenna.

The spacecraft is mechanized such that in the cruise mode of operation, the gyros and the science instruments will not be on at the same time. This is required to maintain the spacecraft power requirements within the solar panel output capabilities. The gyros will be on during the midcourse maneuver and during any acquisition periods.

During planet encounter however, all science instruments will operate despite the status of the gyros. This time is the most critical as far as getting science data is concerned and every means of getting all possible scientific data will be taken. Should the gyros be on during encounter and the solar panels be unable to supply the necessary power the battery will supply the additional power to operate the spacecraft.

E. DEEP SPACE INSTRUMENTATION FACILITY (DSIF)

The DSIF consists of four permanent stations, a mobile station, and a launch station. The permanent stations are located at Goldstone, California; Woomera, Australia; and Johannesburg, South Africa. Each permanent station is equipped with an 85-foot diameter parabolic-reflector antenna. Two stations, Echo and Pioneer, are located at Goldstone. The mobile station (MTS) is currently located within the boundries of the Johannesburg station and is equipped with a ten-foot-diameter parabolic-reflector antenna. This station is used for initial acquisition and tracking of the spacecraft. Block diagrams of the DSIF stations are shown in Appendix B.

1. Launch Station (DSIF 0)

The launch station is located at Cape Canaveral near Launch Complex 12. It provides a checkout facility for the spacecraft while it is in the launch area and serves as a receiving station during the booster flight phase. It consists of two trailers, one containing a receiving system and a command checkout system; the second serves as an instrumentation system which records doppler and telemetry data.

2. Mobile Tracking Station (DSIF 1)

The MTS uses a standard, phase-locked 960-mc/s receiver diplexed with a 25-watt transmitter giving precision two-way doppler capability. Trajectory data must be available to facilitate early acquisition on the Mariner R first pass over South Africa.

3. Goldstone Pioneer Station (DSIF 2)

The Goldstone Pioneer Station will be used as a primary low noise receiving station for the Venus mission. This station has a standard, phase-locked 960-mc/s receiver. A low-noise Maser amplifier and parametric amplifier plus a 960-mc/s circular-polarized listening feed have been installed to increase receiver sensitivity and reduce the system noise temperature. In addition, a cassegrain feed system is utilized to increase antenna efficiency.

4. Goldstone Echo Station (DSIF 3)

The Echo Station will be used as the primary Goldstone transmitting station. The station has a 10 KW 890-mc/s transmitter to provide both precision two-way doppler and spacecraft command capability. A Read-Write-Verify unit is incorporated in the command system and allows readback and confirmation of transmitted commands. The primary function of this station during the mission will be to command the spacecraft and to provide the transmitted signal for obtaining precision doppler. This station has the capability of transmitting real time telemetry data (received from DSIF 2) via high quality phone lines directly to the computer.

5. Woomera Station (DSIF 4)

The Woomera Station has a standard phase-locked 960-mc/s receiver diplexed with an interim 50-watt 890-mc/s transmitter to provide precision two-way doppler during the early phases of the flight. The primary function of this station during the mission will be to track the spacecraft, obtaining precision doppler, engineering and scientific telemetry and tracking data.

6. Johannesburg Station (DSIF 5)

This station has a standard phase-locked 960-mc/s receiver diplexed with a 10 KW 890-mc/s transmitter to provide both precision two-way doppler and spacecraft command capability. A Read-Write-Verify unit is incorporated in the command system and allows readback and confirmation of transmitted commands. The primary function of this station during the mission will be to track the spacecraft, obtaining precision doppler, engineering and scientific telemetry and tracking data.

7. Communications

The primary communications link for the DSIF overseas stations will be teletype. Goldstone utilizes teletype and a high quality data phone circuit. On launch day, and as required throughout the tracking mission, standard telephone communications will be established from the Net Control to all stations. The phone link will be used as fast, direct communications during critical periods.

F. MISSION EVENTS SUMMARY

1. Liftoff
   a. AMR reports liftoff and main events to SFOC at JPL.
   b. CCF starts computation of DSIF prediction data based on actual liftoff time.
   c. S/C is transmitting data at 33 bits per second.
2. DSIF 0 acquires (L + 10s)
3. Booster cutoff (L + s)
4. Atlas-Agena-B separation (L + 300s)
5. First Agena-B ignition (L + 349s)
6. Net Control transmits acquisition data to DSIF 1, 4, 5. (L + 360s)
7. DSIF 0 loss of lock (L + 438s)
8. First Agena-B burnout. (L + 500s) Agena-B and S/C are now in nominal 100 mile parking orbit
9. Second Agena-B ignition. (L + 1334s)
10. Second Agena-B cutoff, injection. (I = L + 1619s)
11. S/C Agena-B separation. (I + 156s)
    a. Transmitter power up
    b. Arm pyrotechnics
    c. Enable CC&S
    d. Agena-B retro maneuver
12. AMR starts transmission of acquisition information to JPL for relay to DSIF 1, 4, 5. (I + 4m)
13. DSIF 1 acquires. (I + 5 m)
14. DSIF 5 acquires. (I + 5 m)
15. a. Unfold solar panels. (I + 17m)
    b. Unlatch radiometer. (I + 17m)
16. DSIF 4 acquires. (I + 24m)
17. Turn-on attitude control system. (I + 33m)
    a. Extend high gain antenna
    b. Activate sun sensor system
    c. Activate gas jet system
    d. Commence sun acquisition

18. Latest time of completion of sun acquisition. Turn off gyros. (I + 63m)

19. The S/C is now transmitting engineering telemetry at 33 bits per second and remains in this condition for approximately 7 days.

20. Remove inhibit on automatic earth acquisition (I + 167h nominally during Woomera visibility).
    a. Start roll search
    b. Turn on gyros
    c. Decrease data rate to 8.3 bits per second

21. Earth acquisition complete. (I + 167.5h)
    a. Roll search stops
    b. Hinge servo starts (until earth seeker acquires an object)
    c. Gyros off
    d. Turn on cruise science. Telemetry is now shared between Engineering and Science.
    e. Switch transmitter from the omni to the high gain antenna
    f. If the high gain antenna has not acquired the earth, roll and hinge CW or CCW override commands will be sent until the S/C acquires the earth.

22. Cruise mode. S/C continues to transmit over high gain antenna. If earth acquisition is lost, the reacquisition sequence is commanded by RTC-1-2-2. Antenna switchover commands, RTC-4 and RTC-5 will be sent as required. The S/C remains in this condition for approximately 80 days. The hinge angle is changed every 16.7 hours to keep the high gain antenna pointed at the earth. Magnetometer and radiometer calibration pulses are supplied to the science equipment every 15.76 hours by the CC&S.

23. Begin encounter sequence (E - 10h)
    a. Turn on encounter science
    b. Switch to encounter telemetry mode. (Both of these are internal S/C commands)
    c. Power is applied to radiometer and infra-red detectors
    d. Radiometer commences planetary scan at 1 deg/sec until the limb of the planet is encountered. The scan rate is then reduced to 0.1 deg/sec.

   e. Back-up ground generated commands can be used to turn on encounter science and switch the telemetry mode if required.

24. Return to cruise mode. (E + 56.7h)
   a. Telemetry switched to cruise mode. Engineering and science data are time shared at 8.3 bits per sec.
   b. Radiometer and infra-red detector power is removed.
   c. Back-up ground commands can be used to turn on cruise mode.
25. Terminate communications by ground command.
   a. Hinge and roll override to point high gain antenna at the sun.

G. ORGANIZATION

The following organization charts depict the mission management. They include the over-all project organization, the DSIF operations organization, and the organization of each DSIF tracking station.

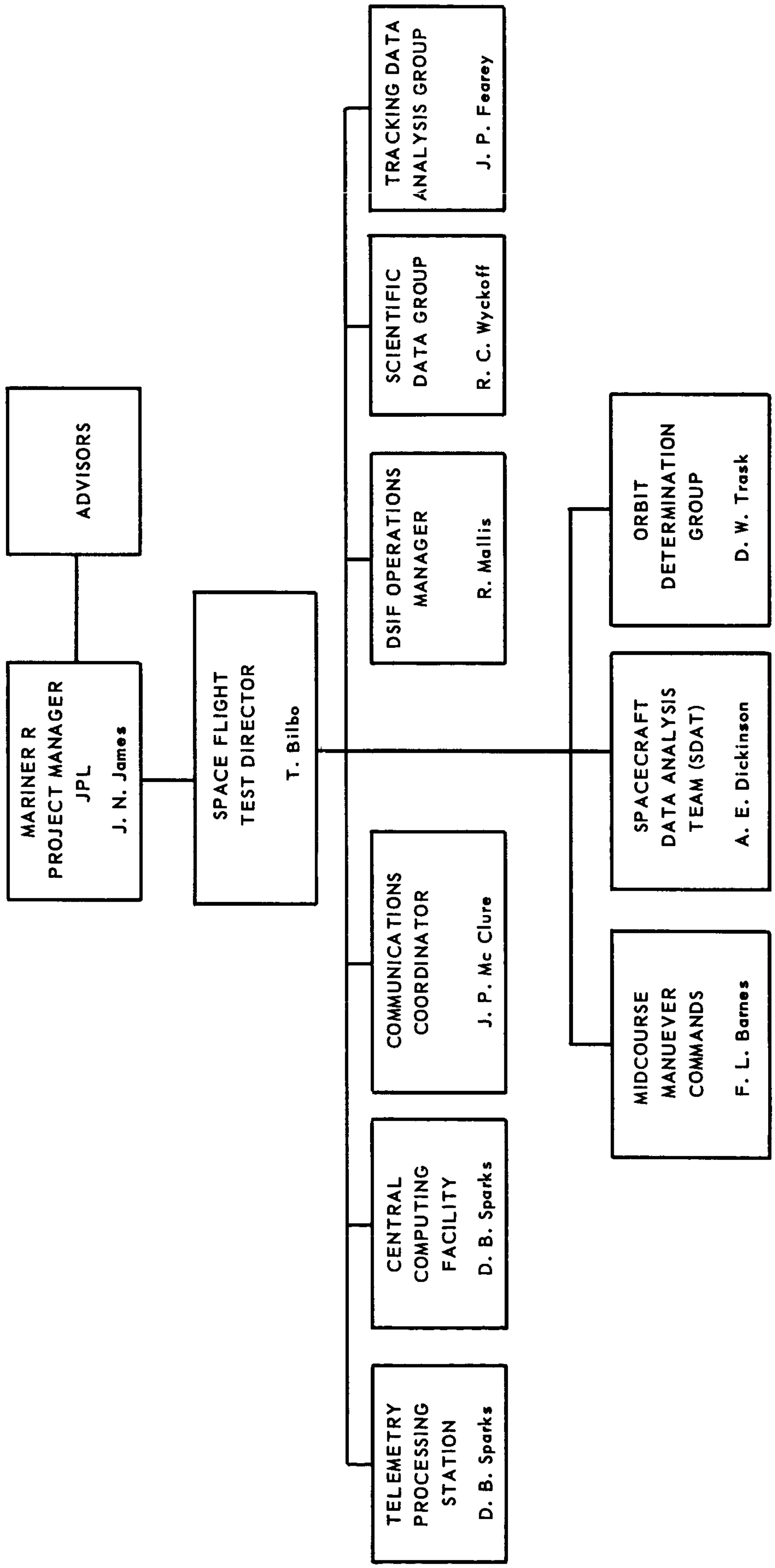

Figure I-3. Mariner R Project Organization

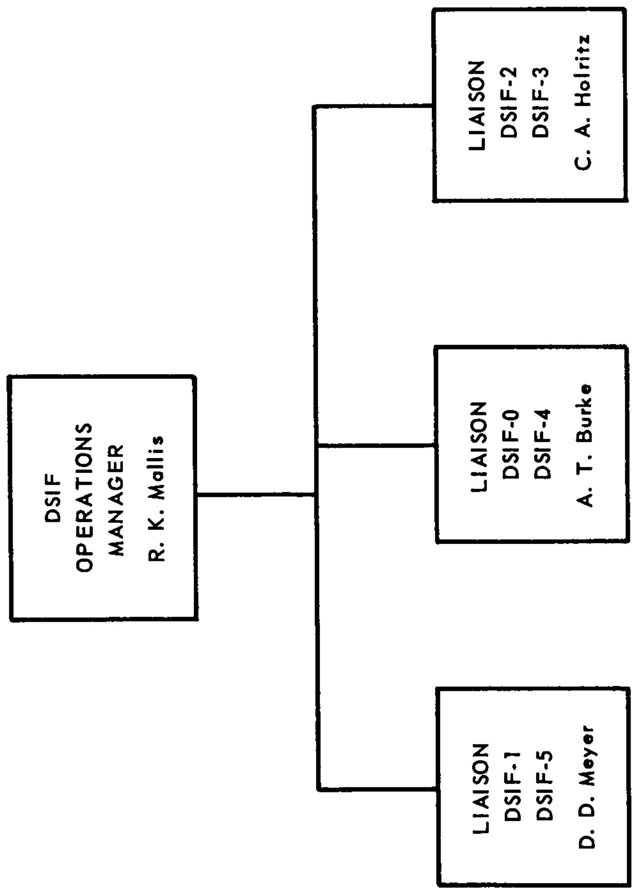

Figure I-4. Net Control Organization

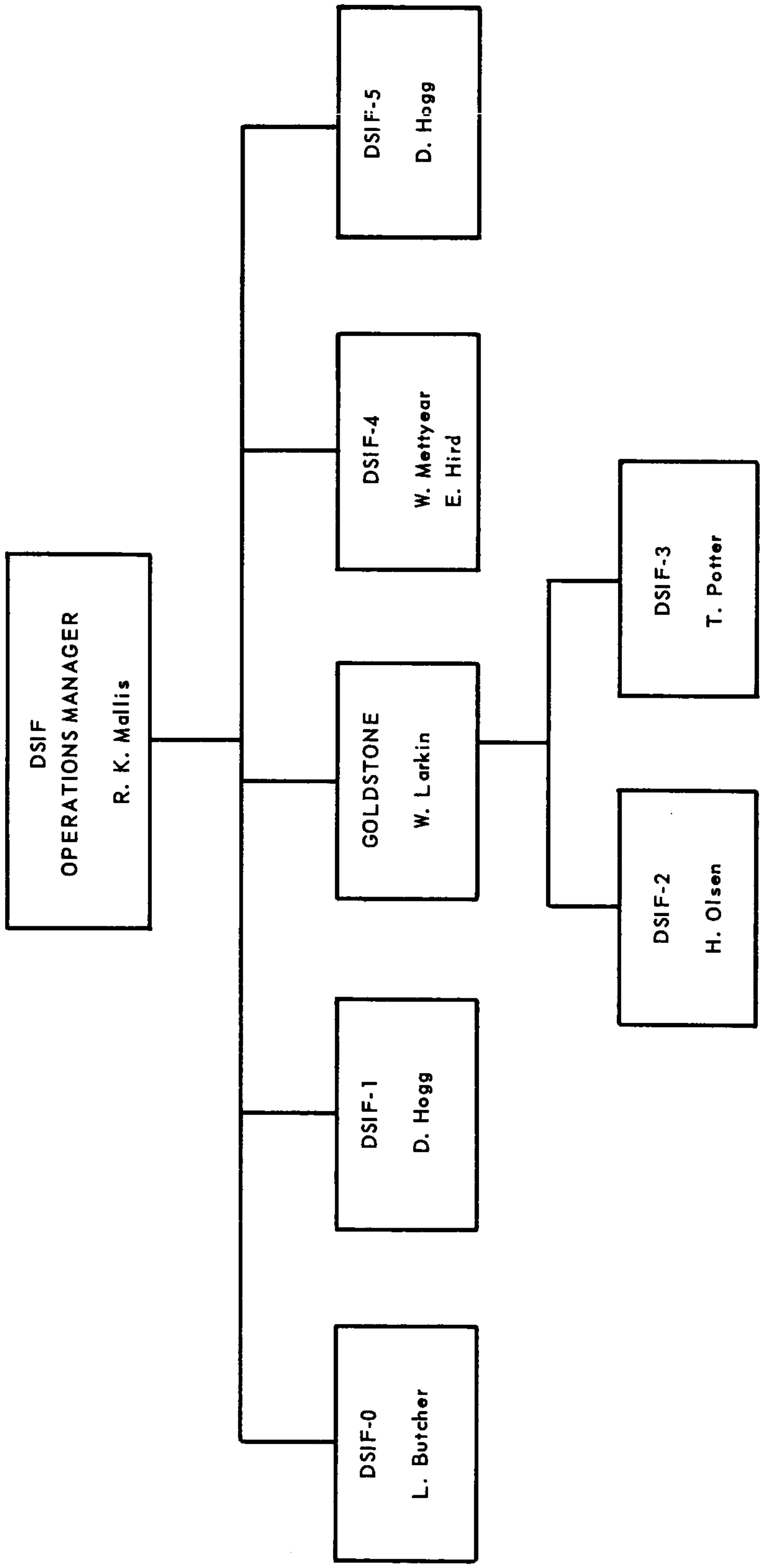

Figure I-5. DSIF Organization

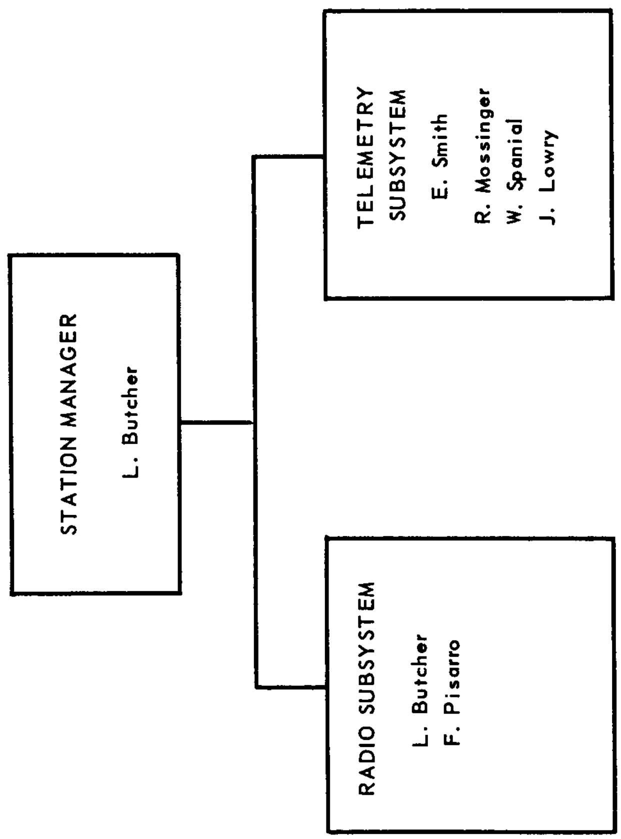

Figure I-6. Launch Station Organization (DSIF 0)

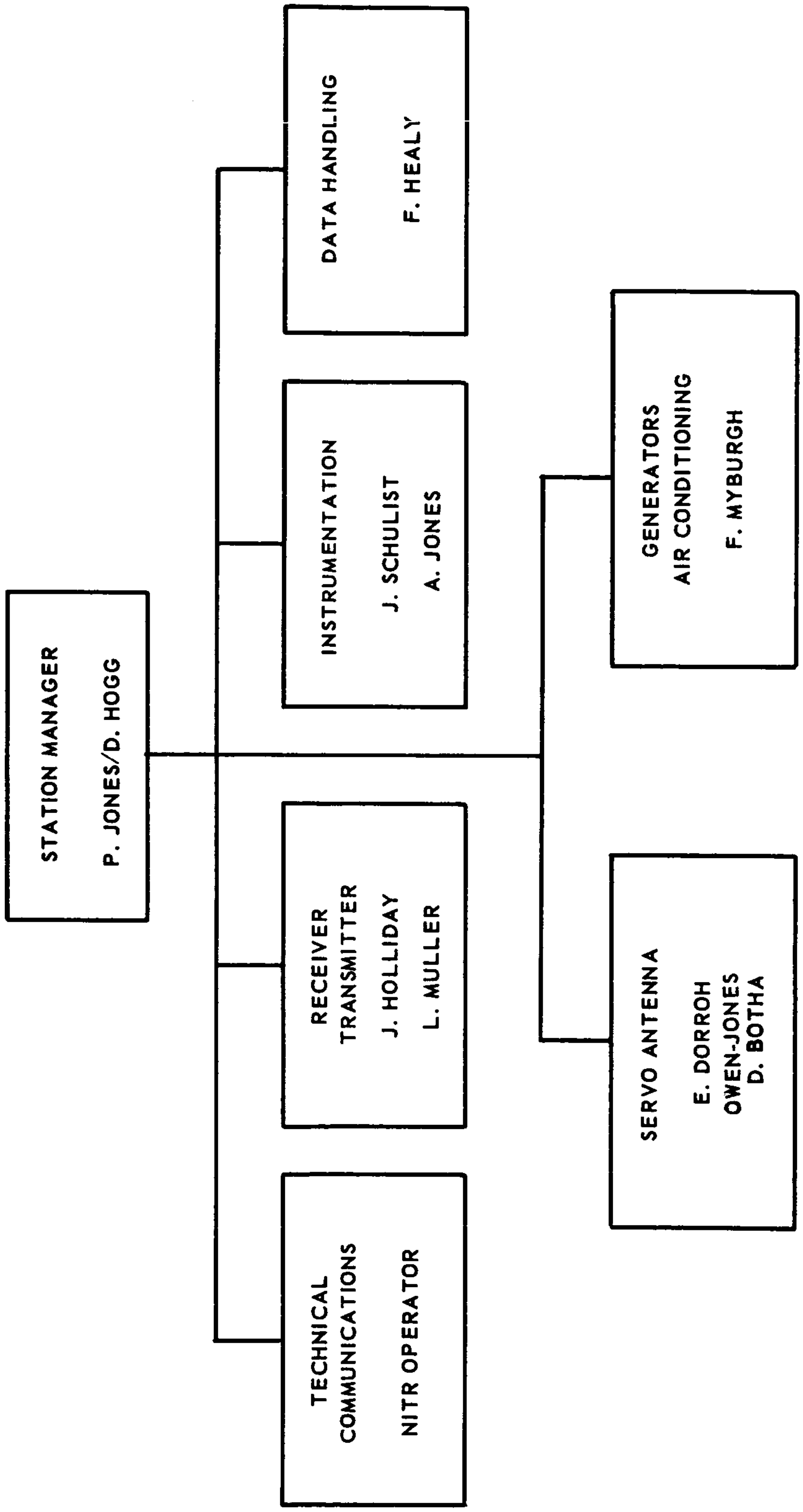

Figure 1-7. Mobile Tracking Station Organization (DSIF 1)

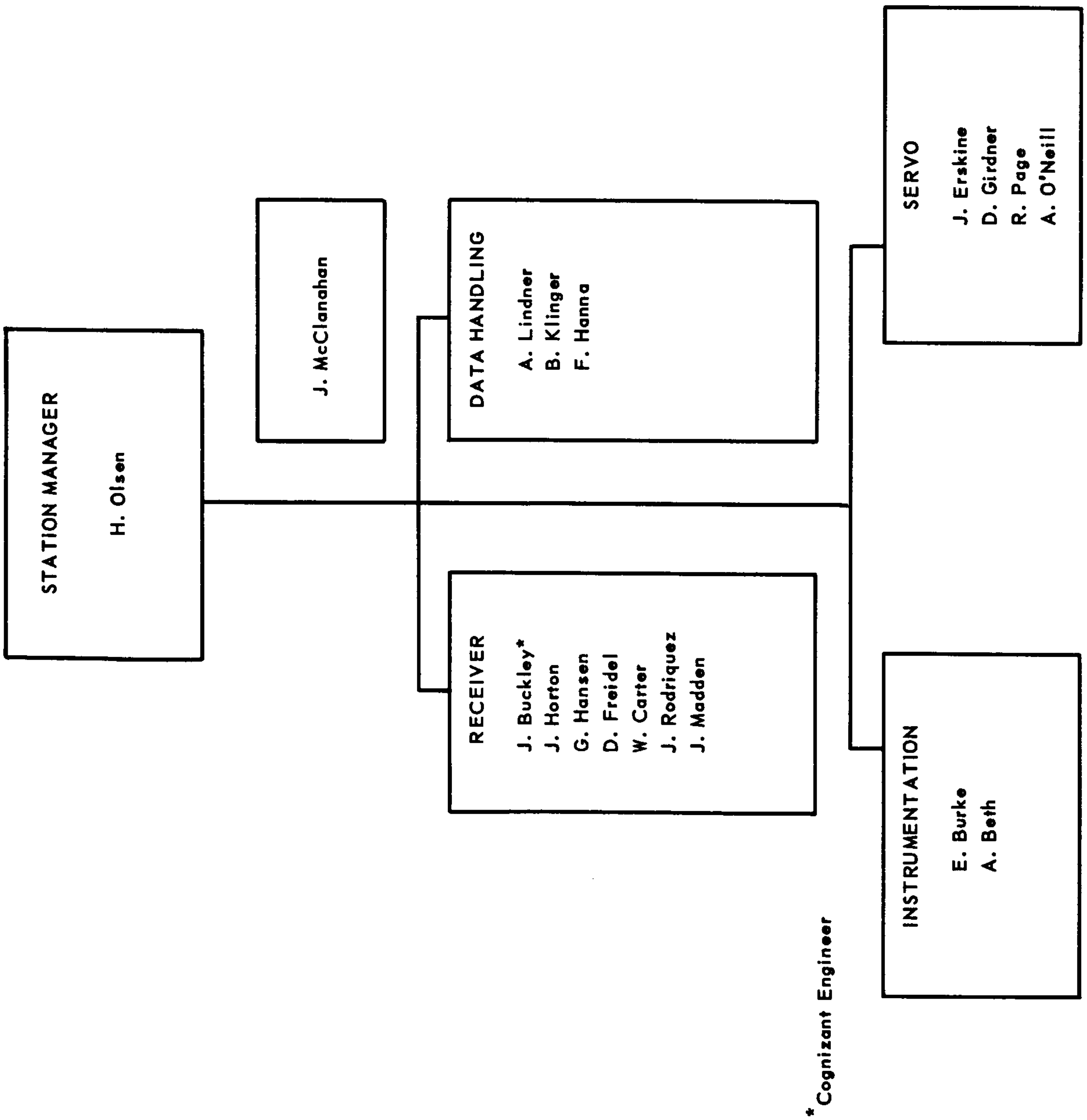

Figure I-8. Pioneer Station Organization (DSIF 2)

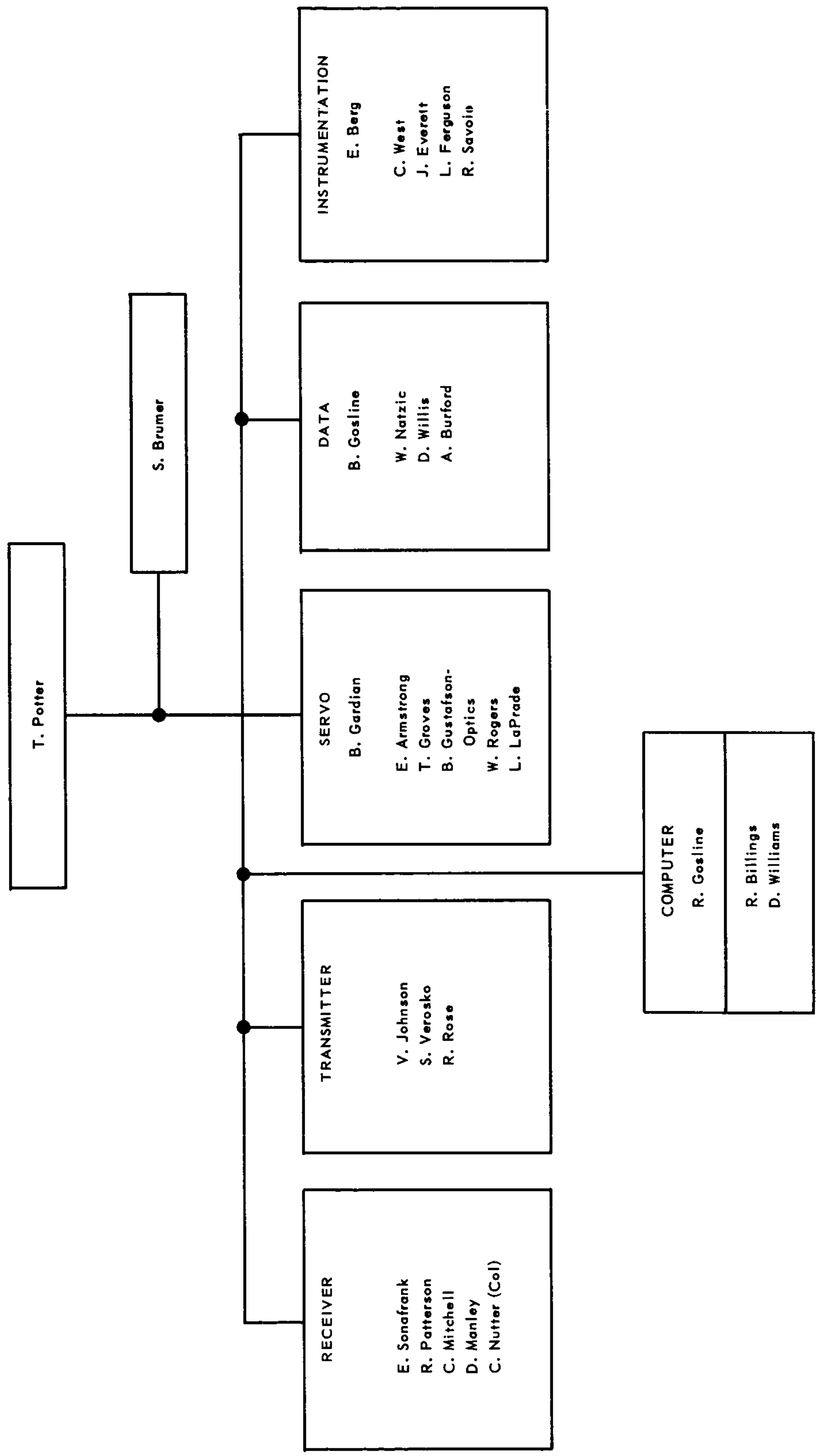

Figure I-9. Echo Station Organization (DSIF 3)

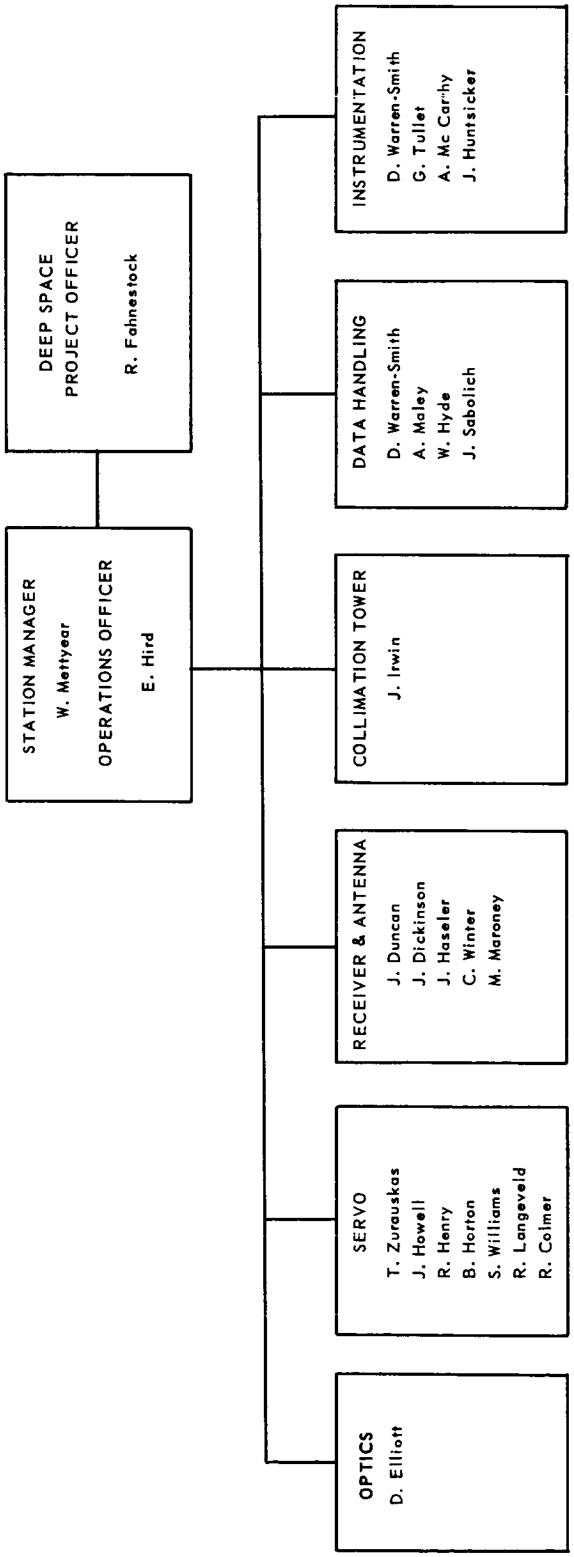

Figure I-10. Woomera Station Organization (DSIF 4)

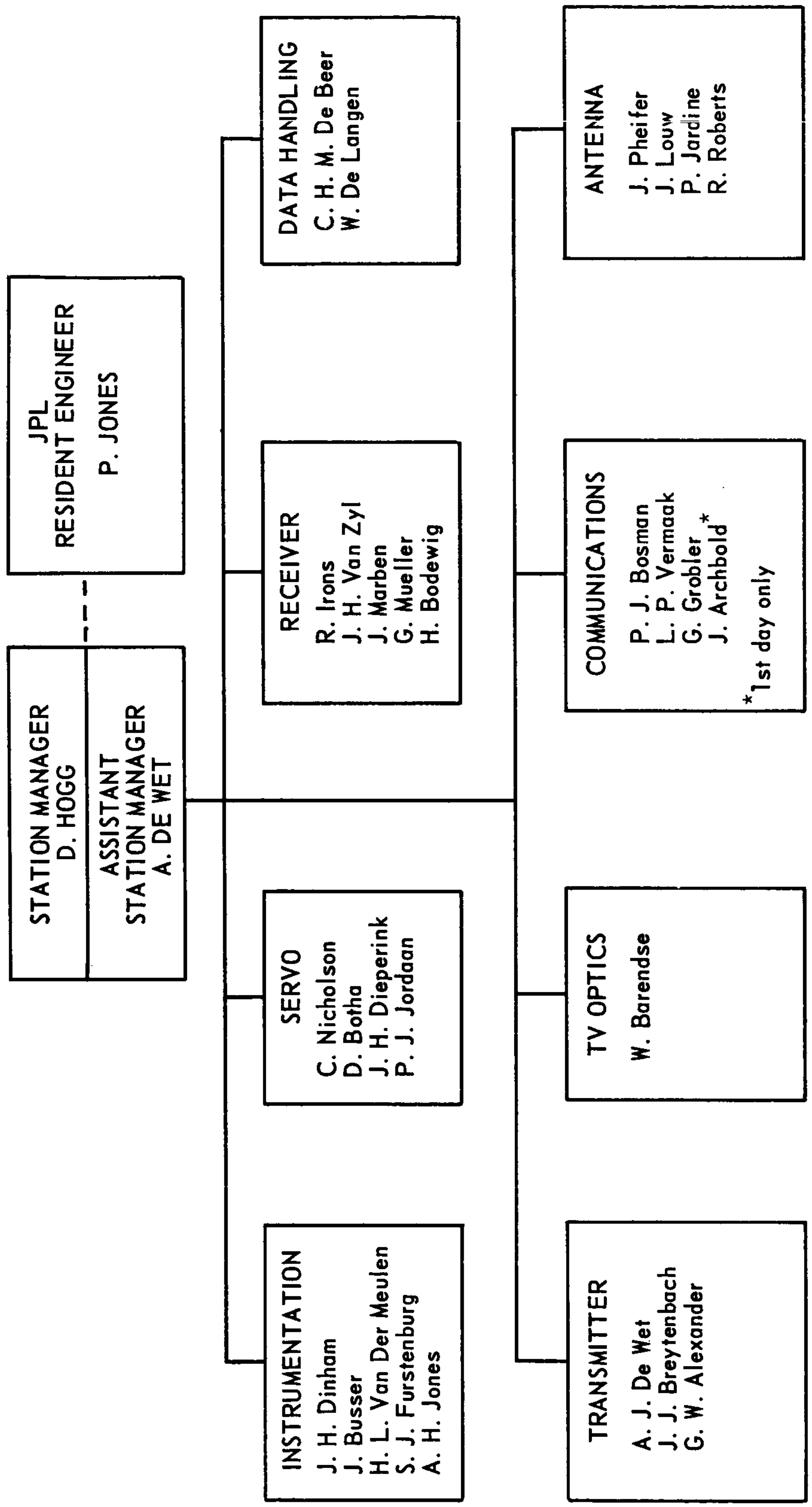

Figure I-11. Johannesburg Station Organization (DSIF 5)

SECTION II

DSIF STATION EQUIPMENT AND DATA REQUIRED

A. STATION EQUIPMENT

The equipment to be used is as follows:

1. DSIF 1, Mobile Tracking Station (MTS) Equipment:
   a. 10-foot Az-El mounted antenna reflector and servo drive system.
   b. 890/960-mc/s monopulse tracking feed.
   c. 890/960-mc/s diplexer.
   d. Digital angle readout equipment (encoders, shift registers, etc.).
   e. Digital tape punch and teletype equipment.
   f. 960-mc/s modified GSDS receiver.
   g. Precision doppler system.
   h. 890-mc/s 25-watt transmitter.
   i. 890/960-mc/s test transponder.
   j. Test telemetry encoder.
   k. Analog oscillographic recorders.
   l. Magnetic tape recorders.
   m. Digital printers.
   n. Telemetry demodulator.

The MTS does not necessarily conform to the Goldstone Duplicate Standard (GSDS); however, the station capabilities are nearly the same as those of the GSDS systems. As used in this station the basic GSDS receiver has been modified to permit installation of a secondary doppler reference loop and a precision doppler measuring system.

2. DSIF 2, Goldstone Pioneer Station
   a. 85-foot polar-mounted antenna reflector and servo drive system.
   b. 960-mc/s listening feed.
   c. MASER preamplifier.

d. Parametric preamplifier.
e. Digital angle readout equipment (encoder, commutators, etc.).
f. Digital tape punch and teletype equipment.
g. 960-mc/s GSDS receiver.
h. Precision doppler system.
i. 890/960-mc/s test transponder.
j. Analog oscillographic recorders.
k. Magnetic tape recorders.
l. Coordinate computer.
m. Telemetry demodulator.

3. DSIF 3, Goldstone Echo Station

a. 85-foot polar mounted antenna reflector and servo drive system.
b. 890/960-mc/s monopulse tracking feed.
c. 890/960-mc/s 10 KW diplexer.
d. Digital angle readout equipment (encoder, commutators, etc.).
e. Digital tape punch and teletype equipment.
f. 960-mc/s GSDS receiver.
g. 890-mc/s 10 KW transmitter.
h. Spacecraft command coder and Read-Write-Verify system.
i. 890/960-mc/s test transponder.
j. Test telemetry encoder.
k. Analog oscillographic recorders.
l. Magnetic tape recorders.
m. Digital printers.
n. Telemetry demodulator.
o. Telemetry to teletype encoder.
p. Telemetry decommutator and display.
q. Teletype encoder phone line modulator.
r. Parametric preamplifier.
s. 890/960-mc/s transmit/listen feed.
t. Atomic frequency standard (AFS).

4. DSIF 4, Woomera Tracking Station
   a. 85-foot polar-mounted antenna and servo drive system.
   b. 890/960-mc/s monopulse tracking feed.
   c. 890/960-mc/s 10 KW diplexer.
   d. 890-mc/s 50-watt interim transmitter.
   e. Digital angle readout equipment (encoders, commutators, etc.).
   f. Precision doppler system.
   g. 960-mc/s GSDS receiver.
   h. Digital tape punch and teletype equipment.
   i. 890/960-mc/s test transponder.
   j. Test telemetry encoder.
   k. Analog oscillograph recorder.
   l. Magnetic tape recorders.
   m. Digital printers.
   n. Telemetry demodulators.
   o. Telemetry decommutator and display.
   p. Telemetry to teletype encoder.
   q. Parametric preamplifier.
5. DSIF 5, Johannesburg Tracking Station
   a. 85-foot polar-mounted antenna reflector and servo drive system.
   b. 890/960-mc/s monopulse tracking feed.
   c. 890/960-mc/s listening & transmitting feed.
   d. 890/960-mc/s 10 KW diplexer.
   e. Digital angle readout equipment (encoder, commutators, etc.).
   f. Digital tape punch and teletype equipment.
   g. 960-mc/s GSDS receiver.
   h. Precision doppler system.
   i. 890-mc/s 10 KW transmitter.
   j. Spacecraft command coder and Read-Write-Verify system.
   k. 890/960-mc/s test transponder.
   l. Test telemetry encoder.
   m. Analog oscillographic recorders.
   n. Magnetic tape recorders.
   o. Digital printers.

p. Telemetry demodulator.

q. Telemetry decommutator and display.

r. Telemetry to teletype encoder.

s. Parametric preamplifier.

B. SPECIAL EQUIPMENT

1. Mariner R Telemetry Data Demodulator

The Mariner R Telemetry Data Demodulator (Fig. II-1) demodulates the biphase modulated signals from the Mariner spacecraft and generates binary digital data which is applied to the Mariner R decommutator, the Telemetry to Teletype Data Encoder and the digital electronics of the magnetic tape recorders.

a. Input Signal

The input signal for the Telemetry Data Demodulator consists of phase-modulated binary information and sync information on two subcarrier frequencies.

1) Data Subcarrier: The phase-modulated binary data may be received by the demodulator at any one of six bit rates. A different subcarrier frequency is used for each bit rate as indicated below:

Bit Rate	Subcarrier Frequency
133	2400 cps
66	1200 cps
33	600 cps
16	300 cps
8	150 cps
4	75 cps

NOTE: The Mariner R spacecraft has only the 33 and 8 bit/second data rates. The pseudo noise (P.N.) code signal is linearly mixed with the data subcarrier.

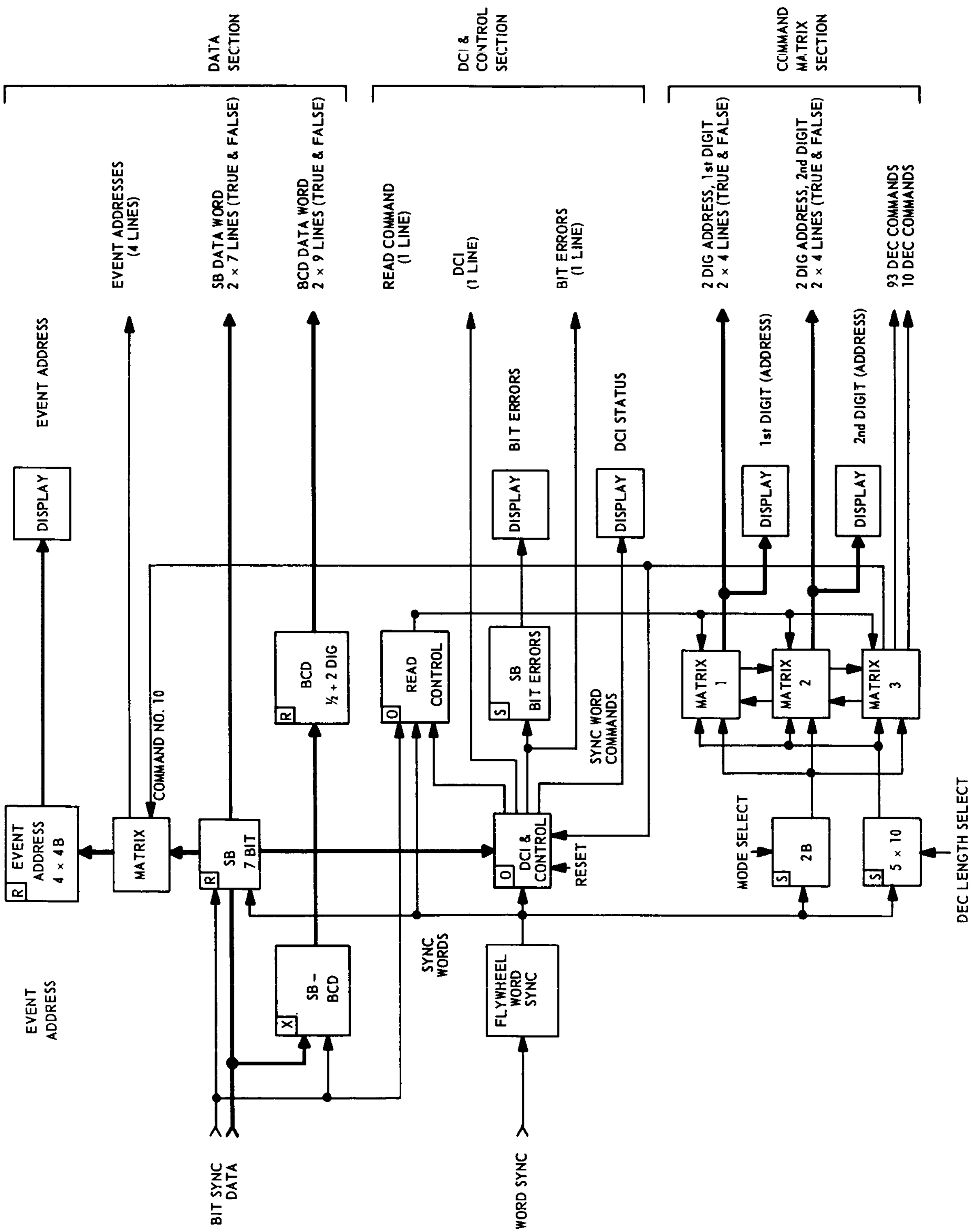

Figure II-1. Demodulator Block Diagram

2) Sync Subcarrier: The sync subcarrier is called f_s. The amplitude of the sync subcarrier is 12.7 db below the amplitude of the data subcarrier. The sync subcarrier is a complex signal consisting of a square wave at $2f_s$ which reverses phase each time the pseudo noise (P.N.) code signal changes from one to zero and vice versa.

b. Output Signal

The output signal consists of binary digital data, a bit sync signal, and a word sync signal. The binary digital data is generated at a level of 0 or -12 volts. The bit sync signal consists of pulses that are one half cycle of $4f_s$ in width. The word sync signal, which groups the binary digital data into seven bit words, also consists of one half cycle of $4f_s$ in width. The word sync signal is generated only when the demodulator is in lock.

The telemetry data demodulator consists of seven subsystems:

1) Data recovery
2) Sync locked loop
3) Data locked loop
4) In lock, out of lock circuit
5) Pseudo noise code generator
6) Phase comparison circuit
7) Power supply

c. Data Recovery

The data recovery circuit filters and demodulates the data subcarrier signal. The biphase modulated data, plus noise is converted to digital binary data. This data is then applied to a matched filter circuit and integrated for one data bit period to determine the polarity of the data bit. The output of the matched filter is fed to a level detector. The level detector drives a data flip-flop circuit which generates the data and data signals.

d. Sync Locked Loop

The biphase modulated input signal is applied to the pseudo noise phase detector. The phase detector detects the phase of the sync signal and phase matches it with the phase of the internally generated pseudo noise code (P.N.) from the pseudo noise generator. When the sync signal and the P.N. signal are aligned, the phase detector and filter generate an f_s signal, which represents the sync signal. The f_s signal is applied to a locked loop which generates an $8f_s$ (or $16f_s$ for 4 bit/second data rate) square wave. This signal is then applied to the sync loop phase detector for comparison with the incoming f_s signal.

e. Data Locked Loop

The operation of the data locked loop is similar to that of the sync locked loop. The $4f_s$ incoming data signal is phase locked with a $32f_s$ VCO signal.

f. In Lock, Out of Lock Circuits

The function of the sync loop and data loop in lock - out of lock circuits is to provide visual indication whether the sync and data loops are in or out of lock.

g. Pseudo Noise Code Generator

The pseudo noise code generator generates the P.N. reference signal, the bit sync signal, the word sync signal and the start and dump pulses. The $8f_s$ from the data loop channel is applied to the data and sync comparison circuits and is divided into $4f_s$, $2f_s$ and f_s signals. These signals are applied to the sync data reference logic circuits. The outputs of the data reference logic circuits are applied to the sync logic circuit and six-bit shift register. The $2f_s$ signal is used to clock-out the shift register outputs. The shift register output is the P.N. code which is applied to the diode logic matrix which in turn modulates the P.N. code with an f_s signal. The modulated P.N. signal is then applied to the sync locked loop. Bit sync, word sync, start and dump pulses are generated from the diode logic matrix.

h. Phase Comparison Circuits

The data and sync comparison circuits compare the phase differences between the $4f_s$, $2f_s$, and f_s sync and data loop signals with the incoming data. The phase differences are displayed on meters.

i. Power Supply

The internal power supply produces regulated +15 volts DC and -15 volts DC voltages for the demodulator.

C. MARINER R TELEMETRY TO TELETYPE DATA ENCODER

The purpose of the Mariner R telemetry to teletype data encoder (Fig. II-2) is to convert the telemetry data format as received from the spacecraft at each DSIF station, to a format suitable for transmission over teletype lines or telephone lines. Each encoder has the capability of producing teletype tape and modulating tone keyers (used on voice circuits) simultaneously.

1. Data Formats

The data output is a "non-return to zero" (NRZ) type of signal with each change of state representing a binary "1". The bit sync and word sync outputs are pulses which are used to synchronize the data extraction process.

The time data is punched on the tape in binary coded decimal form with each of the six digits occupying four of the five holes available in each teletype tape character as shown in Fig. II-3. The data and word sync information is punched in binary form and occupies eight of the ten holes available in two teletype characters. The fifth hole in each character is used for parity information and is punched when the number of punched data holes in the other four digits is odd, thus producing an even number of punched holes for each character of data. When teletype commands are injected in the format, a parity code is not generated.

The carriage return and line feed teletype functions, which violate the parity check, are included such that a page printer will print the data in a uniform format and communications personnel will be able to determine major teletype system malfunctions. Because the data transmission is not a plain language type transmission, the data printout on a page printer will not be suitable for visual monitoring, except to determine that the basic format is correct.

Two other teletype characters are used which violate the parity check. Two characters of " space" indicates that time data follows, and two characters of the figure " 5" indicates out of lock. A double transmission of these characters is used to minimize the probability of data characters, with a parity error, indicating either of these functions.

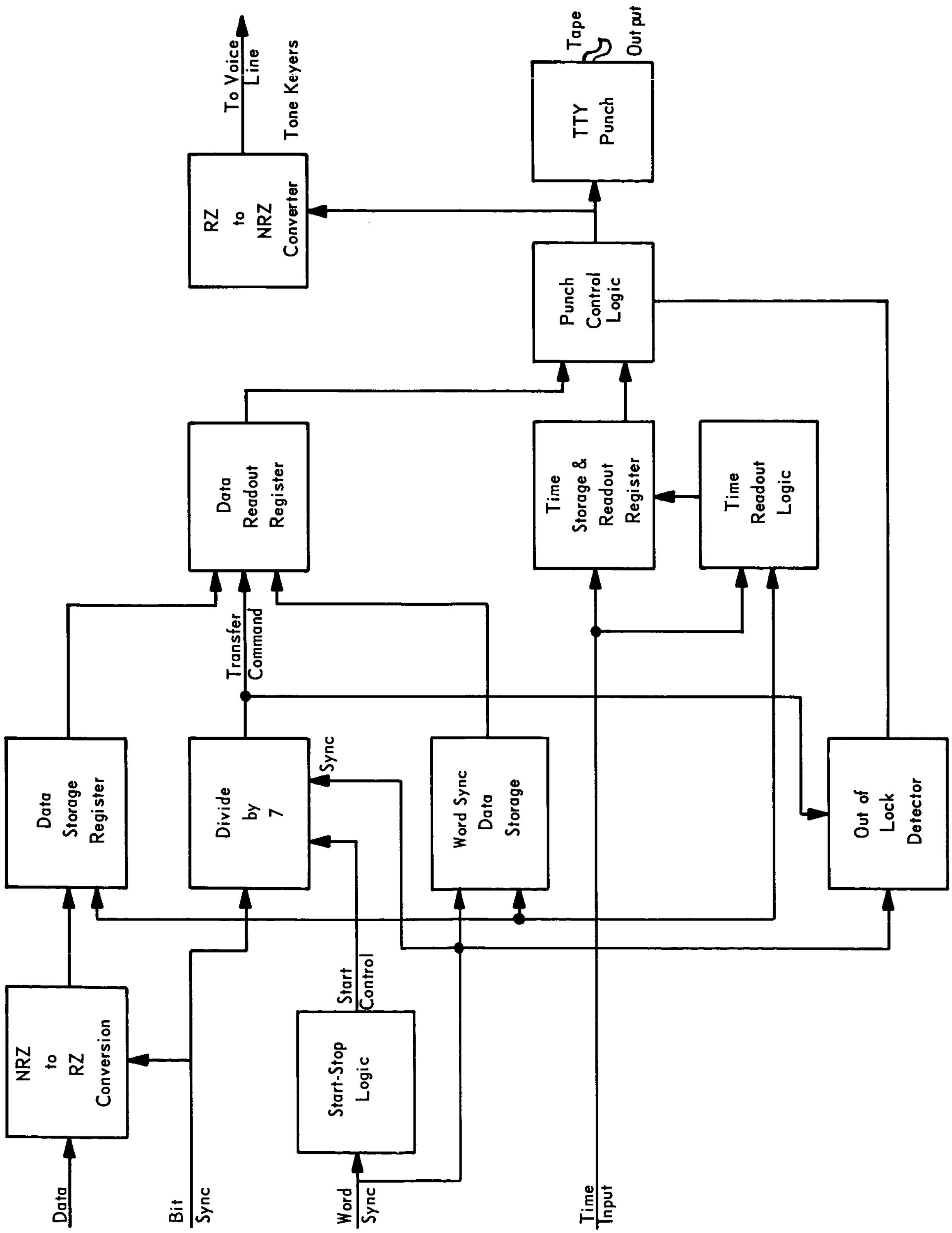

Figure II-2. Telemetry to Teletype Encoder Block Diagram

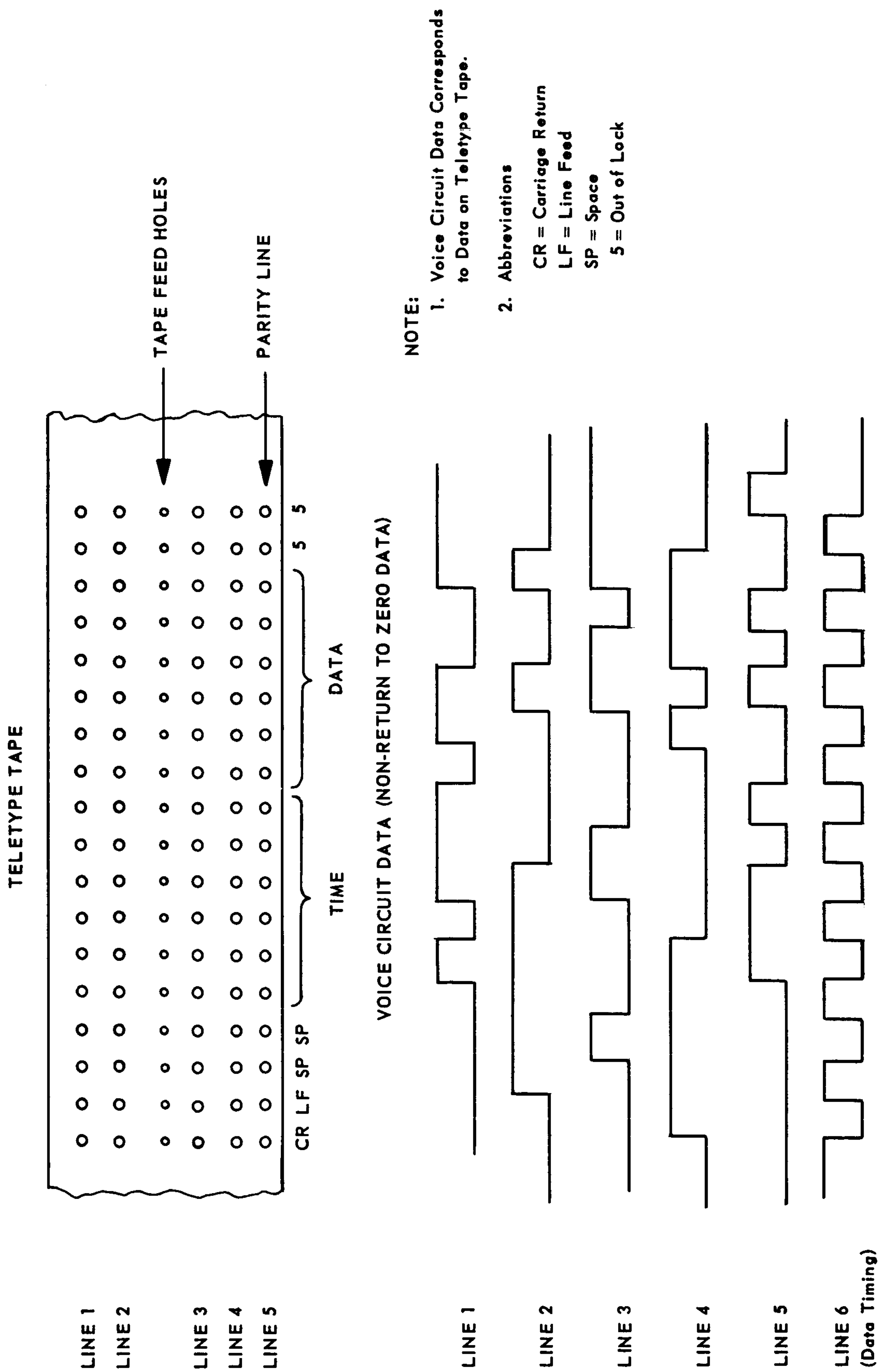

Figure II-3. Teletype and Voice Circuit Data Formats

2. Encoder Operation

The encoder operation is started when a word sync pulse is received from the demodulator (in-lock indication) and the start time in hours, minutes and seconds, GMT, is stored and punched on the tape. The incoming data on the data line is converted from "non-return to zero" to "return to zero" type data and stored in the storage register. When a complete word of 7 bits is received and stored, it is transferred to a readout register along with the stored word sync data and from this register is punched on the tape.

In the operation of the telemetry demodulator, word sync pulses can be missing and to ensure proper operation of the encoder, an internally generated word sync pulse is derived by counting 7 of the bit sync pulses, which are always available. The internally generated word sync pulse is used to perform the data transfer and readout and is resynchronized every time a word sync pulse is received from the demodulator. If a series of nine word sync pulses from the demodulator are missing, the demodulator is considered to be out of lock. The encoder determines when this condition occurs by counting the number of consecutive missing pulses and generates an out of lock printout on the tape as well as stopping the data readout. When a word sync pulse is again received, the encoder restarts with a new cycle of operation.

To provide time readout at frequent intervals, a time label is injected in the data format every five minutes. This time readout corresponds to the time when the first bit of the data word following the time printout was received by the encoder.

To provide signals for operation over voice lines, the data input to the punch is connected to a converter which converts the signals to a "non-return to zero" type data which then modulates 5 tone keyers. A sixth tone keyer provides data timing information for retiming the data at the receiving station.

D. ENGINEERING TELEMETRY DECOMMUTATOR

The engineering telemetry decommutator (Fig. II-4) receives its signal from the telemetry demodulator. This signal is composed of digital, serial data, bit sync and word sync. The function of the decommutator is to recognize the discrete frame sync addresses (first frame sync is seven "1" bits, second frame sync is seven "0" bits) and reset the rate 1, rate 2, and rate 3 address counters. The serial data is then converted to parallel data. Data display is provided at DSIF 3, DSIF 4 and DSIF 5. The outputs of the four S/C event counters are also displayed on the decommutator front panel.

The Mariner decommutator was originally designed to be used with the Mariner A system. Since the Mariner R has reduced capabilities, the decommutator is not utilized to its fullest extent. The Mariner R system has only three commutator rates, consequently the rate 3 and 4 address counters step together and the rate 5 counter is not used.

The system operation is as follows: The serial binary data is coupled to a 7 bit shift register; the shift register output decommutator is presented at the decommutator output in the form of parallel binary data. In parallel with the 7 bit shift register is a serial to binary coded decimal converter. Read commands are generated in the command matrix section and "clock" the data out of the shift registers at appropriate times. Word sync is counted by the address counters and is also used for Data Condition Indication (DCI). Word sync is first coupled to a fly-wheel word sync circuit, this circuit continues to generate word sync, even with the loss of word sync from the demodulator (loss of word sync in the demodulator indicates demodulator out-of-lock). When the decommutator has not received 9 word syncs, the DCI is changed to "questionable". If another 9 word syncs are not present, the DCI is changed to "bad" and the address counters are reset to zero. The address counters will not start counting until a word sync is received from the demodulator.

A mode selector switch allows the decommutator to cycle with or without the 24 science data words. Mode A switches out the address 20's counter, Mode B switches the 20's counter into the decommutator cycle. Deck length

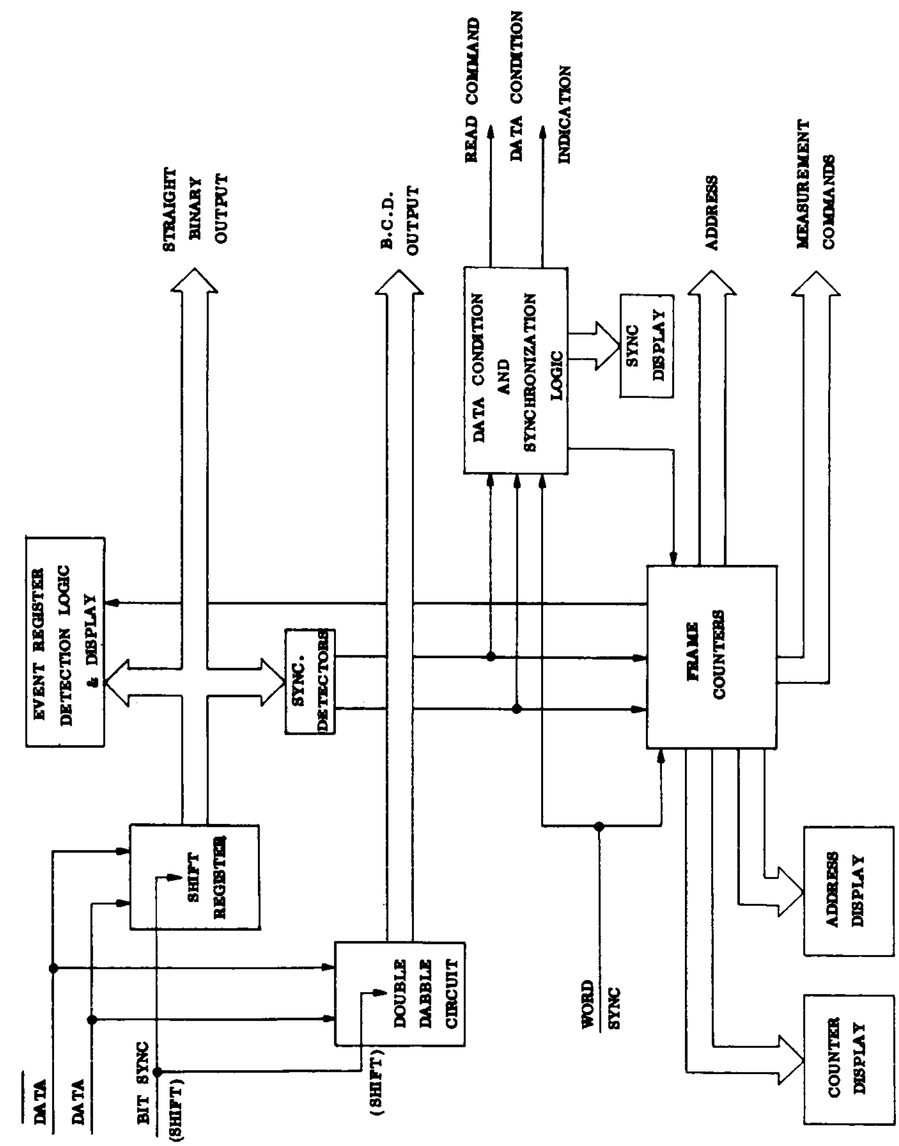

Figure II-4. Digital Decommutator Block Diagram command switches allow the lengths of the commutator decks to be preset. For the Mariner R mission, Decks 1, 3, and 4 are set for 10 positions (i.e., low deck command on 0, high deck command on 9). Deck 2, for science words is set to accommodate the 24 science data words. The low command is set on 0, the high command is set on 3. A deck 2 range switch sets the number of times the address counter will cycle. For Mariner R, the switch is set in the 20-30 range. Four event counters are displayed on the front panel. The four event command counters are multiplexed in the spacecraft, the event command output is addressed. The decommuator event counter logic recognizes the address and shifts the event counter word into the proper counter.

Address commands are generated within the address logic circuits. Certain address commands and data are sent to the remote display. These data will display the spacecraft transponder static phase error, and AGC. The command oscillator frequency is displayed at the RWV.

E. INTERIM TRANSMITTER, WOOMERA DSIF 4

An interim 50 watt transmitter (Fig. II-5) will be used at Woomera for the Mariner R missions. The primary purpose of this capability is to provide precision two-way doppler for early, accurate orbit determination.

This interim system will be similar to the GSDS systems in operation at DSIF 3 and DSIF 5, with the following exceptions:

1) No command capability.
2) Reduced power output.

Ultra stable oscillators are utilized for either spacecraft frequency. An X30 multiplier is employed in the precision doppler loop.

F. READ-WRITE-VERIFY SYSTEM

The purpose of the Read-Write-Verify (RWV) system (Fig. II-6) is: to read incoming information; verify that the information is correct; transform the data into a form suitable for transmission; read the transmitted signal; verify the signals correctness; and write, by means of a punched tape, the transmitted command.

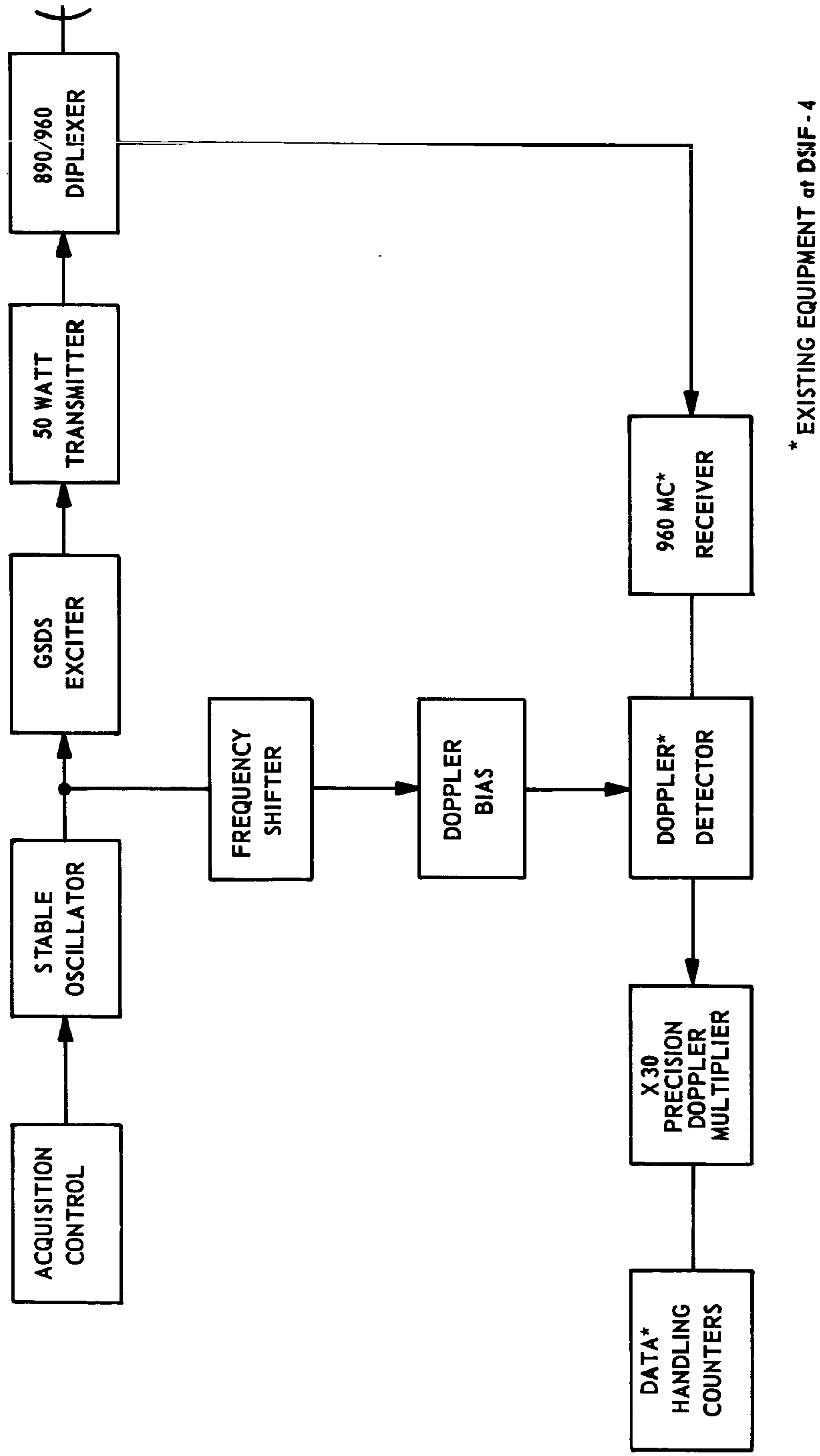

Figure II-5. Fifty Watt Transmitter System (DSIF 4)

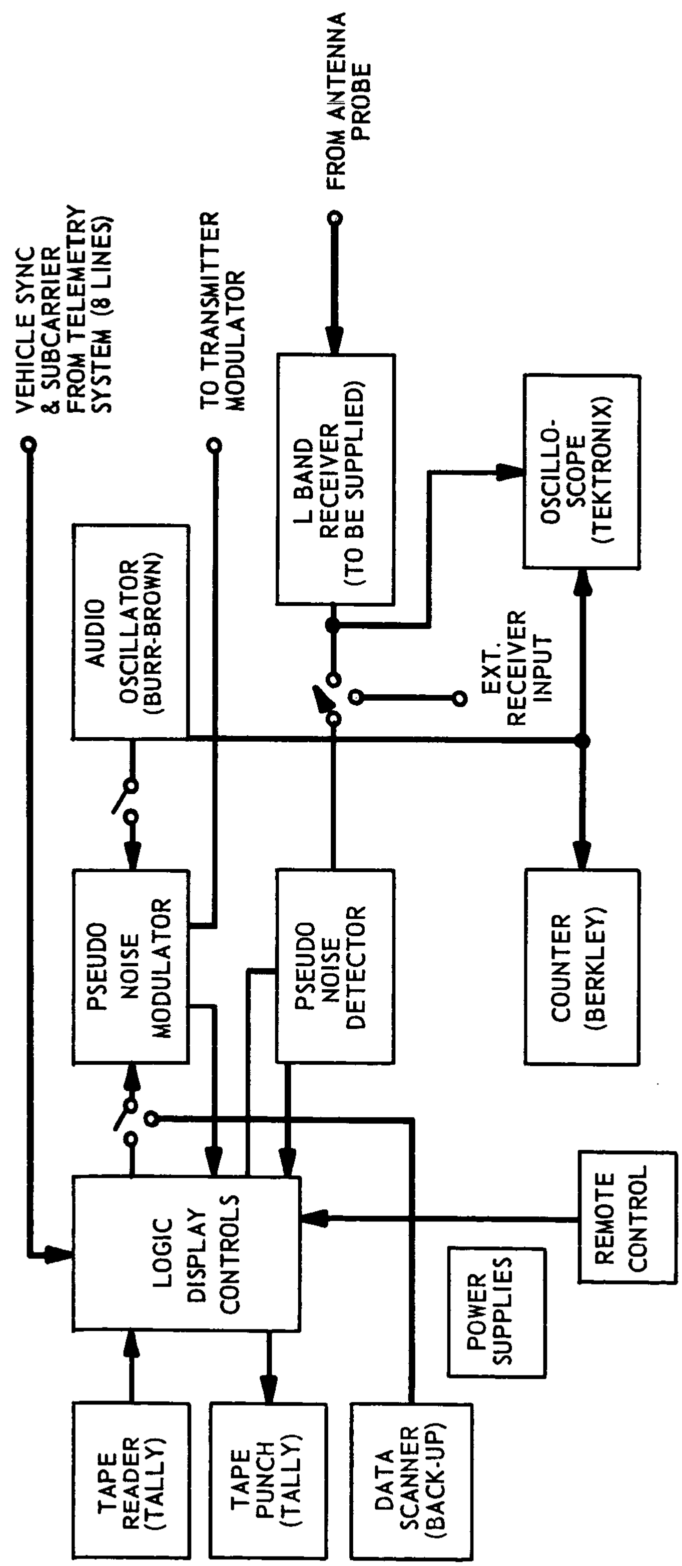

Figure II-6. Command Read-Write-Verify Subsystem Block Diagram

The RWV system consists of; a tape reader, logic and display controls, a pseudo-noise modulator, a fork oscillator, an auxiliary oscillator, a 890 mc/s phase locked receiver, and a pseudo noise detector. An oscilloscope and a frequency counter have been built into the system for testing.

A pre-punched tape or a paper tape received over the teletype line is fed to the tape reader. In Mode 1, the information is checked by redundance and displayed. In Mode 2, the pseudo noise equipment is cycled to verify its operation. The output of the modulator is connected to the input of the detector during this mode of operation. For transmission, the modulator output is connected to the RF transmitter driver (modulating amplifier) as an external antenna probe and feeds the detector, the output of which is checked, displayed and punched on paper tape. In the event of an over-all failure in the logic and control circuitry, a simple scanning device is included with a self-contained power supply to scan the command word as manually read in with a series of switches.

1. Modes of Operation

a. The RWV will verify incoming command data by accepting a paper tape which has three identical commands punched on it. The RWV will compare the commands, display them and indicate the existence of any errors.

b. In order to verify the ground encoding electronics a sample word is inserted into the system and information bits are clocked out to the P.N. modulator. This signal is directly demodulated and compared with the inserted word. In the event of disagreement, an error indication is displayed.

c. When the command data is transmitted a gate is closed to the transmitter modulator and information bits are clocked to the modulator at a 1 bit/second rate. The information is compared and, in the event of an error the command transmission is automatically inhibited.

d. RF energy is fed from the antenna probe to the receiver. The receiver output is demodulated and compared with the word stored. In the event of an error, the command transmission is automatically inhibited.

e. The transmitted command signal, as received from the antenna probe, is punched on paper tape in the same form as the original command.

Additionally, spacecraft vehicle sync is fed from the telemetry decommutator. In the event of loss of vehicle sync, the command transmission will be inhibited. The incremental spacecraft command VCO subcarrier frequency is also displayed at the RWV. This display assists the operator in obtaining initial spacecraft command system lock.

G. ACQUISITION AID, WOOMERA, DSIF 4

The technical feasibility of the "L" band acquisition system was proven at the Johannesburg station during the Ranger 3 and 4 missions. Since it is possible that Woomera will have acquisition problems similar to those at Johannesburg (acquisition with only nominal prediction data), it became important that this system be installed at Woomera for the Mariner R missions.

The purpose of this system is to provide detection and automatic angular acquisition of a spacecraft within the beamwidth of the acquisition antenna. The system consists of a quad-helical array with a comparative circuit, console control panel and associated circuitry. Fig. II-7 is a simplified block diagram of the proposed system. The quad-helix will be mounted on the quadripod area of the 85-foot dish. The design specifications for this antenna may be summarized as follows:

1) Gain: 18 db nominal
2) Half-power beamwidth: 22°
3) Side lobe level: 12 db or less
4) Difference channel null depth: 30 db
5) Polarization: right circular
6) Ellipticity: 2 db or less
7) V.S.W.R. (comparator outputs): 1.5 to 1 or less
8) Weight: less than 50 lb
9) Size (approximately): 15 x 15 x 30"

The control panel contains the control for the switching circuitry, indicator lights, and the electrical biasing circuits for boresight shifting the error signals from the acquisition system. The biasing circuitry will provide the fine collimating of the RF axes of the two antennas.

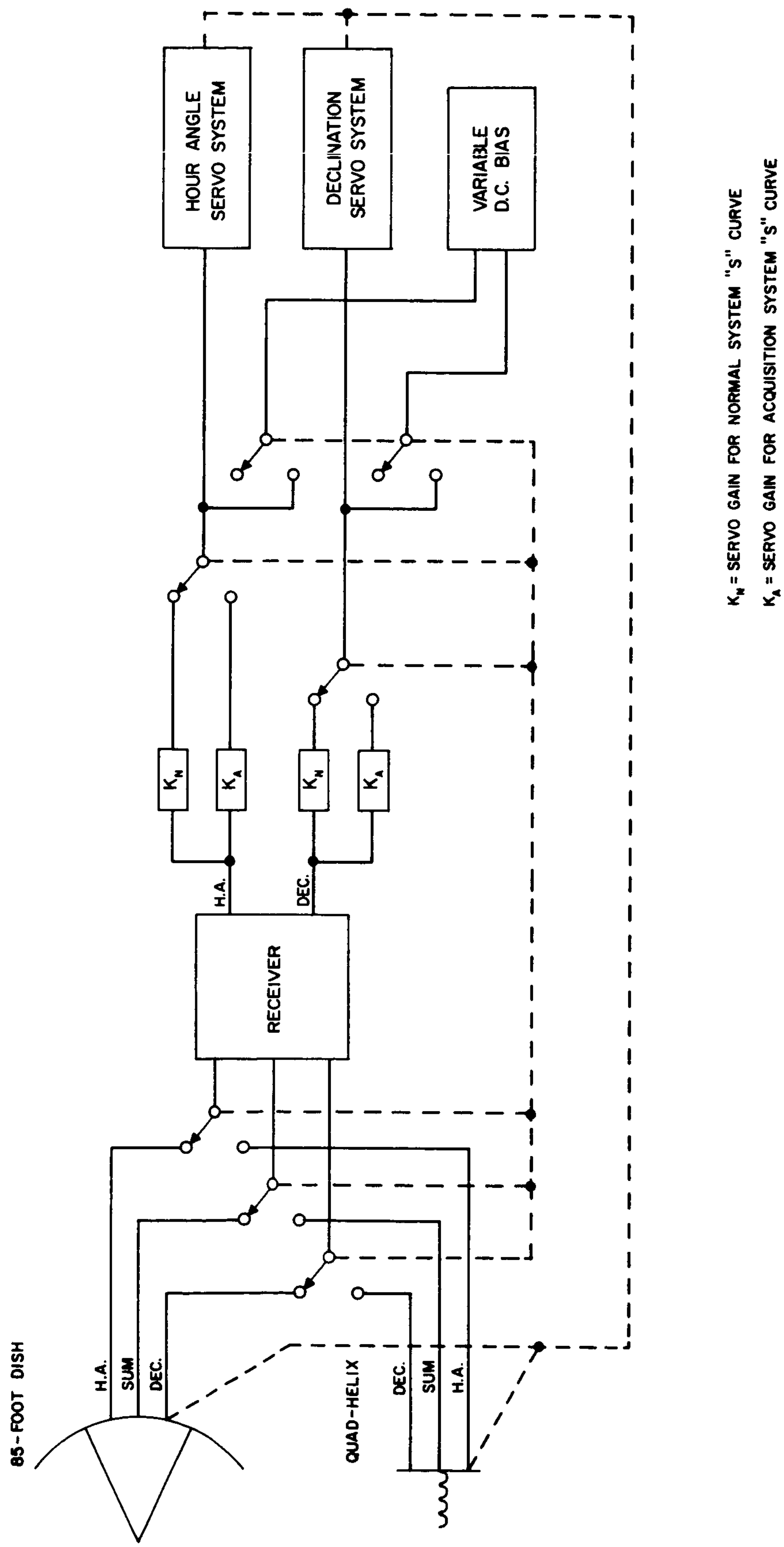

Figure II-7. Acquisition System Block Diagram

H. DATA REQUIRED*

1. Tracking and Telemetry Data Required:
   - a) GMT
   - b) HA-Dec angles from DSIF 2, 3, 4, and 5.
   - c) Az-El angles from DSIF 1 .
   - d) Doppler frequency measure.
   - e) Transmitter frequency from DSIF 1, DSIF 3, DSIF 4 and DSIF 5.
   - f) Bias oscillator frequencies.
   - g) Standard oscillograph and magnetic tape recordings
   - h) Telemetry punched paper tapes from DSIF 3, 4, and 5.
   - i) Station log.
   - j) Calibration data sheets.
   - k) Checkout sheets.
   - l) Command system TTY tapes from DSIF 3 and DSIF 5.
2. Pre-Track Calibration Data Required:
   - a) RF noise figure.
   - b) Optical boresight as indicated by the angle readouts.
   - c) RF boresight shift (parallel polarization, -120 dbm signal level, observe angle readouts).
   - d) Signal strength (-90 dbm to threshold).
   - e) RF static phase error (±3 volts).
   - f) Reference channel dynamic phase error (±90 degrees).
   - g) RF angle errors (DSIF Stations 2, 3, 4, 5 ±0.1°, MTS ±1.0°) at signal levels of -110 dbm, -120 dbm, -130 dbm, and -140 dbm.
   - h) Data condition and mode switches.
   - i) Telemetry threshold (75 percent in lock signal level).
   - j) Transmitter power for DSIF 1, DSIF 3, DSIF 4, and DSIF 5.
   - k) Command system modulation index for DSIF 3 and DSIF 5.
   - l) Command frequencies for DSIF 3 and DSIF 5.

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* For all stations unless otherwise noted.

3. Post Track Calibrations

The necessary post track calibrations are dependent upon the station manager's judgment and may be abbreviated to a large extent. However, the post calibrations should include all of the data in Section II C 2, with the following simplifications:

a) Calibrate the RF static phase error for only ±1.0 volt.

b) Calibrate the RF angle errors only in the signal strength region actually tracked (e.g., if the signal strength at acquisition was -120 dbm and had dropped to -128 dbm at the end of the tracking period, then calibrate the RF angle errors at -120 dbm and -130 dbm).

c) It is not necessary to repeat telemetry threshold calibrations unless there is a possibility of threshold degradation.

d) Amplitude modulation post calibrations are necessary only if spacecraft tumbling was evident during tracking.

SECTION III

ACQUISITION AND TRACKING PROCEDURES

The methods used for acquisition of the spacecraft signal vary between stations. Prediction data are furnished throughout the mission and are derived from various sources. The prediction data derivation is as follows:

1) Prior to the mission all stations are provided with precomputed prediction data such as time-tagged tracking angles, received frequency, doppler shift data, and expected signal strength. These data are presented as tabular printouts and plots in Volume II of this document. These predictions are derived from precomputed standard trajectories.
2) After launch the Central Computing Facility (CCF) and the AMR computer (IPP) will provide prediction data for DSIF 1, DSIF 4, and DSIF 5. Three sets of prediction data will be computed and transmitted to these stations. The initial set will be based upon actual launch time and will assume nominal launch vehicle performance. The second set of prediction data will be based upon AMR tracking data during the Atlas and first-Agena-burn powered flight and will assume nominal second Agena burning. The third set of prediction data will be based upon AMR tracking data from the entire launch vehicle powered flight. All stations will use the most up-to-date prediction data.
3) After the DSIF stations have acquired the spacecraft transmission, prediction data will be derived from the DSIF tracking data by the CCF and will be transmitted to each DSIF station prior to its tracking period. See Section VII and Section V-A.

The nominal injection of the spacecraft occurs near the DSIF 1 and DSIF 5 horizon, consequently angular and doppler rates will be high during the initial portion of the view period. The Mariner ascent trajectory also has higher velocity than the previous Ranger trajectories, therefore, initial doppler rates will be higher.

Certain launch azimuths will cause the spacecraft to set on the DSIF 1 and DSIF 5 eastern horizons 20 to 30 minutes after injection. The spacecraft could rise again on the eastern horizon as late as 200 minutes after it set.

The general procedure when acquiring the transponder signal will be to monitor the console-mounted spectrum analyzer. A signal on the spectrum analyzer will indicate that the antenna is pointed in the proper direction and the receiver can then acquire the signal.

It has been found that when the receiver is tuned quite rapidly through the signal spectrum, the beat note of the carrier will be more noticeable than when the receiver is tuned slowly. This may vary considerably with different operators.

The spacecraft transponder differs from that used in the Ranger series in that the transponder receiver locked loop has only a 20 cps noise bandwidth, whereas the Ranger transponders had a noise bandwidth of 100 cps. When sweeping the ground transmitter, the sweep rates must be correspondingly slower in order to lock up the spacecraft transponder.

Servo bandwidth changes will be made at various times during a tracking period. The intial phase of tracking in the high speed rate range should be done in the 0.2 cps servo bandwidth. When, because of the vehicle rates, the antenna is switched to low speed, the low speed servo bandwidth should be set at 0.1 cps. Once the transient from high speed to low speed switching has died out, the RF error meters should be monitored to determine when to further reduce the servo bandwidth. If the tracking rate is smooth and the error signals are holding zero, the bandwidth can be left at 0.1 cps until the rate becomes essentially constant. At this time it can be switched to 0.025 cps and left there for the remainder of the track. If the error signals become excessively noisy during the period that the tracking rates are changing, then the servo bandwidth should be reduced until the tracking is smooth. This should not be the case, however, as the signal strength should be quite strong during this period. Following this initial tracking period and with the possible exception of acquisition, the servo should be left in the 0.025 cps bandwidth. If at any time there is a lag in the antenna tracking, as evidenced by the error meters holding a mean other than zero, then the servo bandwidth should be increased until it is eliminated.

A. INITIAL ACQUISITION

1. Mobile Tracking Station (DSIF 1)

a. Position the antenna using the prediction data pointing information for the given launch trajectory.

b. Using the prediction data frequency information, manually tune the receiver until it acquires one-way RF lock. Notify Net Control of two-way acquisition. Put the doppler data condition switch in "one-way" position. Continue with c, below. If one-way RF lock cannot be obtained within 10 minutes after nominal acquisition, obtain approval from Net Control to commence the following special scanning procedure:

1) Place the antenna at 70° elevation, rotate in azimuth 360° at an angular rate of 10 degrees/second.
2) When a 360 degree sweep in azimuth has been completed, reverse the azimuth rotation and lower the elevation angle 8 degrees. Continue this procedure in increments of 8 degrees and rotating the azimuth through 360 degrees until the local horizon is reached. Notify Net Control of the results.
3) While rotating in azimuth monitor the 30 mc/s spectrum analyzer. If the signal appears on the analyzer, stop the azimuth angle sweep and, while keeping a signal on the analyzer by moving the antenna in azimuth and elevation, tune the receiver through a frequency range of ±20 kc around the nominal frequency.

c. After obtaining approval from Net Control for two-way acquisition, sweep the transmitter frequency until the spacecraft transponder receiver acquires RF lock. This will be evidenced either by a phase transient in the ground receiver followed by a changing static phase error, or by the ground receiver completely dropping lock.

d. Reacquire receiver lock if necessary and notify Net Control of two-way lock.

e. Change the doppler data condition switch to "two-way" position. Continue with f, below. If two-way lock cannot be obtained:

1) Place "good-bad" data switch in "good" position.
2) Set the transmitter VCO to the nominal value. If DSIF 5 has acquired and synchronized the telemetry demodulators and decommutator, obtain spacecraft AGC information from that station. Slowly adjust the transmitter VCO 500 cps above and below the nominal value. DSIF 5 will notify DSIF 1 if any changes occur in the transponder AGC.
3) Report the results of the above test to Net Control and await instructions.

f. Set in doppler bias by adjusting the transmitter VCO frequency. Place the "good-bad" data switch in the "good" position.

g. Commence monitoring the transmitter frequency (see Section V) and record any changes in frequency with the time of the change. Use a 10 second frequency count. <u>Notify Net Control before the frequency is readjusted.</u>

h. Lock up telemetry demodulator.

i. At the time specified by Net Control, rapidly tune the transmitter "high" in frequency so that the spacecraft transponder receiver will drop lock. Place "good-bad" data switch in "bad" position.

j. Reacquire one-way RF lock.

k. Change the data condition switch to "one-way" position.

l. Place the "good-bad" data switch in "good" position.

m. Monitor the transmitter VCO frequency and record any changes in frequency with the time of the change.

n. Relock up the telemetry demodulator.

o. When DSIF 5 acquires two-way lock, reacquire RF lock if necessary.

p. Change the data condition switch to "pseudo-two-way" position.

2. Johannesburg (DSIF 5)

a. Position the antenna using the prediction data pointing information for the given launch trajectory.

b. Switch in acquisition aid antenna.

c. Using the prediction data frequency information, manually tune the receiver until it acquires one-way RF lock. Place the doppler data condition switch in the one-way position if the Mobile Tracking Station (DSIF 1) is not in a two-way lock position. If DSIF 1 is in two-way lock, place the switch in the pseudo-two-way position. Notify Net Control of the RF lock condition. Continue with d, below. If one-way RF lock cannot be obtained, continue searching along the standard trajectory, monitor the 30-mc/s spectrum analyzer, and:

1) If the signal appears on the spectrum analyzer:
   (a) Attempt to peak the signal.
   (b) Obtain one-way RF lock.
   (c) Place the doppler data condition switch in one-way position.
   (d) Monitor the RF angle error meters.
   (e) Notify Net Control of results and continue at d, below.
2) If the signal has not been acquired within 20 minutes after the time of nominal acquisition:
   (a) Set the antenna into a spiral scan about the nominal launch trajectory. Use scan pattern parameters that correspond to the nominal angular rates.
   (b) Notify Net Control of results.

d. Null out RF angle errors; put the antenna servo system in the automatic mode.

e. Place the "good-bad" data switch in the "good" position.

f. Lock up the telemetry demodulator. Check to see that DATA, not $\overline{\text{DATA}}$, is being fed to the decommutator and telemetry to teletype encoder.

g. If DSIF 1 acquires two-way lock before or after steps c through f are completed, they will have to be repeated.

h. When the angular rates are less than 0.5 degree/second and are nearly constant, switch the acquisition aid out of the system.

i. Request permission from Net Control to turn on transmitter.

j. Net Control will notify DSIF 1 to turn off their transmitter at a specified time.

k. Reacquire one-way RF lock if necessary.

l. Turn on transmitter at time specified by Net Control; sweep the transmitter frequency until the spacecraft transponder receiver acquires RF lock. This will be evidenced either by a phase transient in the ground receiver followed by a changing static phase error, or by the ground receiver dropping lock.

m. Reacquire receiver lock if necessary, and notify Net Control of two-way lock.

n. Change the doppler data condition switch to "two-way" position. Continue with step o, below. If two-way lock cannot be obtained:

1) Place "good-bad" data switch in the "good" position.
2) Set the transmitter VCO to the nominal value, monitor the spacecraft AGC (channel B-5, address 15). If the readout is greater than 100, the transponder receiver is probably in lock. If the B-5 readout is less than 90, readjust the transmitter frequency 500 cps below the nominal frequency. Continue this procedure until there is a transponder AGC indication or until the entire transmitter frequency region has been covered.
3) Report the results of the above to Net Control and await instructions.

o. Set in the doppler bias by adjusting the transmitter VCO. Place the "good-bad" data switch in the "good" position.

p. Commence monitoring the transmitter frequency (Section V) and record any changes in frequency with the time of the change. Use a 10-second frequency count. Notify Net Control before the frequency is readjusted.

3. Woomera (DSIF 4)

a. Position the antenna using the prediction data pointing information for the given launch trajectory.

b. Switch in acquisition aid.

c. Using the prediction data frequency information, manually tune the receiver until it acquires one-way RF lock. If the Mobile Tracking Station (DSIF 1) or Johannesburg (DSIF 5) are not in a two-way lock condition, place the doppler data condition switch in the one-way position. If DSIF 1 or 5 is in two-way lock, place the switch in the pseudo-two-way position. Notify Net

Control of the RF lock condition. Continue with step d, below. If one-way RF lock cannot be obtained, continue searching along the standard trajectory, monitor the 30-mc/s spectrum analyzer, and:

1) If the signal appears on the spectrum analyzer:
   (a) Attempt to peak the signal.
   (b) Obtain one-way RF lock.
   (c) Place the doppler data condition switch in the one-way position.
   (d) Proceed with step d, below
2) If the signal has not been acquired within 20 minutes after the time of nominal acquisition:
   (a) Set the antenna into a spiral scan about the nominal launch trajectory. Use scan pattern parameters that correspond to the nominal angular rates.
   (b) Notify Net Control of results.

d. Null out RF angle errors; put the antenna servo system in the automatic mode.

e. Place the "good-bad" data switch in the "good" position.

f. Lock up the telemetry demodulator. Check that DATA,not $\overline{\text{DATA}}$, is being fed to the decommutator and the telemetry to teletype encoder.

g. If DSIF 1 or 5 acquires two-way lock before or after steps b through e are completed, these steps will have to be repeated.

h. When angular rates are less than 0.5 deg/second and are nearly constant, switch the acquisition aid out of the system.

i. Turn on transmitter at time specified by Net Control; sweep the transmitter frequency until the spacecraft transponder receiver acquires RF lock. This will be evidenced either by a phase transient in the ground receiver followed by a changing static phase error, or by the ground receiver dropping lock.

j. Reacquire receiver lock if necessary, and notify Net Control of two-way lock.

k. Change the doppler data condition switch to "two-way" position. Continue with step j, below. If two-way lock cannot be obtained:

1) Place "good-bad" data switch in the "good" position.

2) Set the transmitter VCO to the nominal value, monitor the spacecraft AGC (Channel B-5 & address 15). If the readout is greater than 100, the transponder receiver is probably in lock. If the B-5 readout is less than 90, readjust the transmitter frequency 500 cps below the nominal frequency. Continue this procedure until there is a transponder AGC indication or until the entire transmitter frequency region has been covered.

3) Report the results of the above to Net Control and await instructions.

l. Set in the doppler bias by adjusting the transmitter VCO. Place the "good-bad" data switch in the "good" position.

m. Commence monitoring the transmitter frequency (Section V) and record any changes in frequency with the time of the change. Use a 10-second frequency count. <u>Notify Net Control before the frequency is readjusted.</u>

n. Turn off transmitter at time specified by Net Control. Place "good-bad" data switch in "bad" position.

o. Reacquire one-way RF lock.

p. Place doppler data condition switch in one-way position.

q. Place "good-bad" data switch in "good" position.

r. Relock telemetry demodulator.

s. When notified by Net Control that DSIF 1 or 5 have acquired two-way lock, place doppler data condition switch in pseudo-two-way position.

4. Goldstone (DSIF 2)

This station does not have automatic tracking capability and therefore the antenna will be positioned in the aided or manual mode.

a. Position the antenna, using the prediction data pointing information.

b. Use the prediction data frequency information and manually tune the receiver until it acquires one-way RF lock. Notify Net Control of "one-way" lock. Ask Net Control if the spacecraft transponder is locked on the transmitter signal from either DSIF 1 or DSIF 5. If either station is in two-way lock, place the doppler data condition switch in the "pseudo-two-way" position. If neither station is in two-way lock, place the switch in the "one-way" position.

c. Continue tracking in one-way lock until Net Control indicates a TTY or voice message stating the time two-way lock is to be attempted.

d. At the specified time, place the "good-bad" data condition switch to the "bad" position. At this time DSIF 3 will sweep the transmitter frequency until the transponder receiver acquires RF lock. This will be evidenced either by a phase transient in the ground receiver followed by a changing static phase error, or by the ground receiver completely dropping RF lock.

e. Reacquire receiver lock, if necessary, and notify Net Control of two-way lock.

f. Change the doppler data condition switch to two-way position.

g. When advised by DSIF 3 that the static phase error has been adjusted and the transmitter VCO locked to the frequency synthesizer, place the "good-bad" data condition switch in the "good" position.

5. Goldstone (DSIF 3)

a. Position the antenna, using the prediction data pointing information.

b. When advised by DSIF 2 that one-way lock has been achieved, check to see that telemetry is being received over the microwave link and then lock up the telemetry demodulator. Check that DATA, not $\overline{\text{DATA}}$, is being fed to the decommutator and the telemetry to teletype encoder.

c. At the time specified by Net Control, sweep the transmitter frequency until the transponder receiver acquires RF lock. This step must be performed in conjunction with DSIF 2). (See Section III, 4-d.)

d. Adjust the transmitter frequency until the transponder static phase error (Channel B-6 and address 16) is 052.

e. Adjust the transmitter VCO until the VCO is locked to the frequency. synthesizer output.

B. ROUTINE RF ACQUISITION

1. Johannesburg (DSIF 5)

a. Position the antenna, using the prediction data pointing information.

b. Use the prediction data transponder frequency information and manually adjust the receiver until it acquires one-way RF lock. Notify Net

Control of one-way lock. Put doppler data condition switch in one-way position or, pseudo-two-way position. When an adjacent station is interrogating the transponder, Net Control will advise the acquiring station of tracking conditions.

c. Continue tracking in one-way or pseudo-two-way lock until Net Control initiates a TTY or voice message stating the time two-way RF lock is to be attempted.

d. At the specified time place the "good-bad" data condition switch in the "bad" position, and sweep the transmitter frequency until the spacecraft transponder acquires RF lock. This will be evidenced either by a phase transient followed by a changing static phase error in the ground receiver or by the ground receiver losing lock. Notify Net Control of two-way lock. Change the doppler data condition switch to two-way position.

e. Reacquire receiver lock if necessary.

f. Place the "good-bad" data switch in the "good" position.

g. Lock up the telemetry demodulators.

h. Monitor channel B-6 readout. Adjust the transmitter frequency until the static phase error (channel B-6 & address 16) readout is 052. Change doppler data condition switch to two-way position.

i. Place the "good-bad" data switch in the "good" position.

2. Goldstone (DSIF 2 & DSIF 3)

The routine acquisition procedures will be the same as those used for initial acquisition (see Section III, A-4 & A-5).

3. Woomera (DSIF 4)

a. Position the antenna using the prediction data pointing information.

b. Use the prediction data transponder frequency information and manually adjust the receiver until it acquires one-way RF lock. Notify Net Control of one-way lock.

c. Switch doppler data condition switch to "pseudo-two-way" if DSIF 3 is interrogating transponder. If DSIF 3 is not interrogating, set the switch to the one-way position.

d. Place the "good-bad" data switch in the "good" position.

e. Lock up the telemetry demodulator.

f. If lock is lost due to Goldstone transmitter going off the air, repeat steps a, b, d, and e. Change the doppler data condition switch to the one-way position when the receiver is in lock.

C. RF ACQUISITION, NONSTANDARD CONDITIONS

1. Loss of Terrestrial Communications
   a. Mobile Tracking Station (DSIF 1)
      1) DSIF 1 is to proceed with standard acquisition procedures using the standard launch trajectory predictions. (Note: The firing will be delayed unless at least one TTY link to South Africa is operational).
      2) If DSIF 1 has not acquired within 10 minutes of predicted time of spacecraft visibility, proceed with procedure outlined in Section III A, 1, b (1).
   b. Johannesburg (DSIF 5)
      1) Proceed with standard acquisition procedure using standard launch trajectory predictions.
      2) If the RF signal has not been acquired within 10 minutes, sweep the antenna along the nominal trajectory, moving in ±10 degree increments north and south of the trajectory.
      3) Continue this procedure until the predicted time of spacecraft visibility is over, or until communications are established.
   c. Woomera (DSIF 4)
      1) Proceed with standard acquisition procedure using standard launch trajectory predictions.
      2) If the RF signal has not been acquired within 10 minutes of the nominal acquisition time, commence a spiral scan along the standard launch trajectory, using scan pattern parameters that correspond to the nominal angular rates.
   d. Goldstone (DSIF 2, DSIF 3)

Since sufficient redundancy in communications circuits exists between Net Control and Goldstone, no nonstandard procedure will be described for loss of terrestrial communications.

2. Loss of Terrestrial Communications Before Launch Azimuth is Known

In the event that communications fail before the launch azimuth is known at DSIF 1 and DSIF 5, or DSIF 4, the antennas will be positioned as though the vehicle had been launched at the earliest possible time. To facilitate positioning the antenna the DSIF stations should plot from the data given in Volume II of the MR-TIM the horizon azimuth angle acquisition time (GMT) for each day of the firing window. If communications are not re-established prior to the station's earliest acquisition time the stations are to assume the vehicle has been launched and position the antenna accordingly. The stations should vary the antenna position according to the plot of angle versus acquisition time until either:

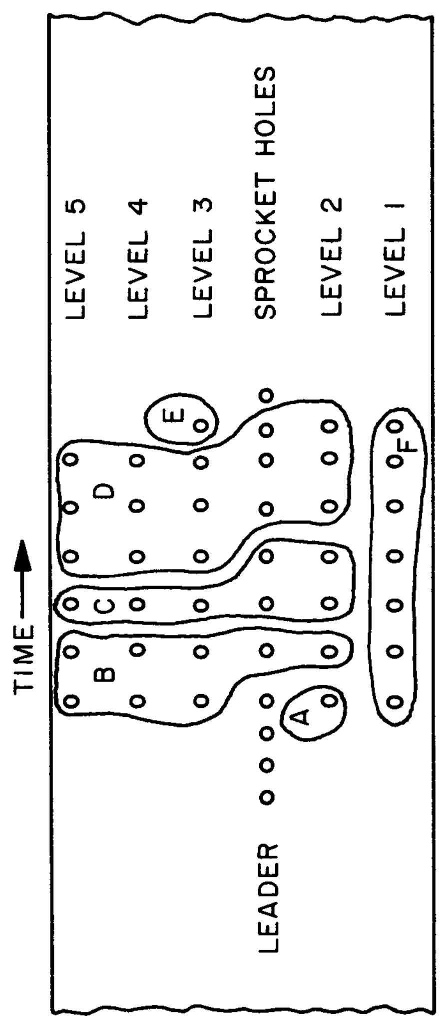
1) Acquisition has occurred, or
2) Communications are established, or
3) The last acquisition time corresponding to the day's firing window has passed.

3. Other Nonstandard Conditions

Because of the number of nonstandard situations which might arise, no further procedures will be discussed. The procedures to be used in the event of a nonstandard condition will be supplied at the appropriate time by Net Control.

D. COMMAND PROCEDURES

During this mission two types of commands will be transmitted to the spacecraft from the DSIF. One type of command, a real time command, will initiate preprogrammed events in the spacecraft. The other type of command, a stored command, will be used to program the spacecraft actions for the mid-course maneuver. See Table III-1 for an explanation of the command functions. These commands, both real time and stored (see Table III-2), will be punched on paper teletype tape (see Fig. III-1) and fed into the tape reader of the Read-Write-Verify (RWV) system which modulates the transmitter. The real time command tapes will be available at the DSIF stations prior to a mission. The stored command tapes will be determined by the Central Computing Facility



A. START BIT
B. COMMAND DECODER ADDRESS
C. CC&S ADDRESS
D. MAGNITUDE
E. POLARITY (SIGN)
F. PARITY

Figure III-1. RWV Command Message Tape Format
(as read by turning over TTY tape)

TABLE III-1. BRIEF EXPLANATION OF COMMAND FUNCTIONS

RTC-1	Roll Override. This command is used in case earth acquisition is lost. The earth sensors are switched out and the spacecraft will roll until the earth sensor detects an illuminated object.
RTC-2	Clockwise Hinge Override. This command changes the hinge angle of the earth oriented high gain antenna. Each command causes the hinge angle to change in an increment of 2 degrees.
RTC-3	Counter Clockwise Hinge Override. This command is the same as RTC-2, except the hinge angle is changed in the opposite direction.
RTC-4	L-Band to Omniantenna. This command switches the transponder output from the high gain, earth oriented antenna to the omniantenna.
RTC-5	L-Band to High Gain Antenna. This command switches the transponder output to the earth oriented high gain antenna.
RTC-6	Initiate Midcourse Maneuver. This command initiates the midcourse maneuver sequence. The spacecraft attitude control is switched to gyro control, the space craft turns are initiated according to the stored command values. The mid-course motor burn is initiated. After completion of motor burn, the spacecraft is re-oriented and solar and earth acquisition procedures are initiated.
RTC-7	Command Encounter Mode. This command turns the planet science "on". Engineering telemetry is switched out and the radiometer scan begins.
RTC-8	Command Planet Science Off. This command returns the spacecraft to the cruise mode. The radiometer is turned off, engineering telemetry is switched into the telemetry system. This command countermands RTC-10.
RTC-9	Command Sun Acquisition. This command unlatches the solar panels and removes the solar acquisition inhibit.
RTC-10	Command Cruise Science Off. This command switches science telemetry off. Only engineering telemetry will be transmitted.
RTC-11	Spare.

TABLE III-1. BRIEF EXPLANATION OF COMMAND FUNCTIONS (Cont'd)

RTC-12	Command Earth Acquisition. This command removes the earth acquisition inhibit, the spacecraft starts a roll search. When the spacecraft earth sensor acquires and nulls on an object, the telemetry data rate is automatically switched to 8.3 bits/second.
SC-1	Midcourse Roll Duration. This command contains the time duration of the midcourse roll maneuver.
SC-2	Midcourse Pitch Duration. This command contains the time duration of the midcourse maneuver pitch maneuver.
SC-3	Midcourse Velocity Increment. This command contains velocity incremental change required for the midcourse motor burn.

TABLE III-2. REAL TIME AND STORED COMMANDS FOR MARINER R

Command ID	Type	Octal Address	Binary Command Address	Binary CC&S Address	Data	Polarity (Sign)
RTC-1	Roll Override	023-00	0010-011	00-000	000-000-000-000	0
RTC-2	Clockwise Hinge Override	025-00	0010-101	00-000	000-000-000-000	0
RTC-3	Counterclockwise Hinge Override	045-00	0100-101	00-000	000-000-000-000	0
RTC-4	Command L-Band to Omniantenna	031-00	0011-001	00-000	000-000-000-000	0
RTC-5	Command L-Band to Directional Antenna	051-00	0101-001	00-000	000-000-000-000	0
RTC-6	Initiate Midcourse Maneuver	052-00	0101-010	00-000	000-000-000-000	0
RTC-7	Command Encounter Mode	032-00	0011-010	00-000	000-000-000-000	0
RTC-8	Command Planet Science OFF	026-00	0010-110	00-000	000-000-000-000	0
RTC-9	Command Sun Acquisition	046-00	0100-110	00-000	000-000-000-000	0
RTC-10	Command Cruise Science OFF	054-00	0101-100	00-000	000-000-000-000	0
RTC-11	Spare	013-00	0001-011	00-000	000-000-000-000	0
RTC-12	Command Earth Acquisition	064-00	0110-100	00-000	000-000-000-000	0
SC-1	Midcourse Maneuver Roll Turn Duration	015-01	0001-101	00-001	xxx-xxx-xxx-xxx	x
SC-2	Midcourse Maneuver Pitch Turn Duration	015-02	0001-101	00-010	xxx-xxx-xxx-xxx	x
SC-3	Midcourse Maneuver Velocity Increment	015-03	0001-101	00-011	xxx-xxx-xxx-xxx	x

TABLE III-3. COMMAND SEQUENCE

1. COMMAND MIDCOURSE MANEUVER SEQUENCE. (L + 8 d)

   a. Transmit SC-1, SC-2, SC-3 and RTC-4 to S/C. (Roll, pitch, velocity and antenna change over.)

2. TRANSMIT MIDCOURSE EXECUTE COMMAND, RTC-6. (L + 8.1 d)

   a. S/C starts propulsion sequence.
      1) Turn on accelerometer.
      2) Turn on gyro.
      3) Turn off cruise science. (Data rate remains at 8.3 bits per second, but only engineering telemetry is transmitted.)
   b. RTC-6 + 60 m.
      1) Turn off earth sensor power.
      2) Inhibit earth acquisition.
      3) Connect roll gyro capacitor.
      4) Set roll turn polarity.
      5) Deploy high gain antenna.
      6) Start roll turn.
   c. Stop roll turn, latest time RTC-6 + 68.7 m.
   d. RTC-6 + 72 m.
      1) Turn on auto pilot.
      2) Switch out sun sensor pitch and yaw errors.
      3) Connect pitch and yaw gyro capacitors.
      4) Set pitch turn polarity.
      5) Start pitch turn.
   e. Stop pitch turn, latest time 16.7 m after start.
   f. RTC-6 + 94 m.
      1) Start accelerometer integration.
      2) Command motor ignition.
   g. Command motor shut off, latest time 2.5 m after start.

TABLE III-3. COMMAND SEQUENCE (CONT.)

h. Turn off auto pilot (RTC-6 + 98 m).

1) Switch out gyro capacitors.

2) Command high gain antenna to reacquisition position.

3) Relinquish CC&S control of gyro power and accelerometer.

4) Commence automatic sun acquisition.

5) Switch in sun sensor error signal.

i. Sun acquisition complete. (RTC-6 + 98 m to 128 m).

1) Turn off gyros.

2) Turn on cruise science (telemetry remains at 8.3 bits per second).

j. Remove inhibit on earth acquisition (RTC-6 + 200 m).

1) Turn on earth sensor power.

2) Turn on gyros.

3) Initiate roll search.

4) Turn off cruise science.

k. Earth acquisition complete. (RTC-6 + 200 m to + 3 m).

1) Switch transmitter to high gain antenna.

2) Turn off gyros.

3) Turn on cruise science.

TABLE III-4. COMMAND INFORMATION MESSAGE FORMATS

A. MIDCOURSE MANEUVER COMMAND MESSAGE*

1. THE THREE STORED COMMANDS FOR THE MIDCOURSE MANEUVER, SC-1, SC-2, AND SC-3 FOLLOW IN SPECIAL CODE. EACH COMMAND IS REPEATED THREE TIMES. THE ORDER IS: SC-1, SC-1, SC-1; SC-2, SC-2, SC-2; SC-3, SC-3, SC-3. (Coded stored commands)
   AT ___________GMT

2. TRANSMIT SC-1, SC-2 AND SC-3 AT XXXXXXZ.

3. TRANSMIT THE ANTENNA SWITCHOVER COMMAND RTC-4 AT

XX HRS	XX MIN	XX SEC	GMT
XX HRS	XX MIN	XX SEC	GMT
XX HRS	XX MIN	XX SEC	GMT

4. TRANSMIT THE EXECUTE MIDCOURSE MANEUVER COMMAND RTC-6 AT

XX HRS	XX MIN	XX SEC	GMT
XX HRS	XX MIN	XX SEC	GMT
XX HRS	XX MIN	XX SEC	GMT

5.

	ADDRESS	DATA	SIGN
SC-1	015-01	2736	1
SC-1	015-01	2736	1
SC-1	015-01	2736	1
SC-2	015-02	3366	Ø
SC-2	015-02	3366	Ø
SC-2	015-02	3366	Ø
SC-3	015-03	Ø621	Ø
SC-3	015-03	Ø621	Ø
SC-3	015-03	Ø621	Ø

RTC-4 AT XXXXXXZ
BACKUP AT XXXXXXZ

*Note: All teletype messages will use the standard address and conclusion formats (see Section VI)

B. SPACECRAFT COMMAND MESSAGE

TRANSMIT RTC-X, XX COMMAND, OCTAL ADDRESS XXX-00, X TIMES AT XXXXXXZ.

C. COMMAND VERIFICATION MESSAGE (DSIF 5 ONLY)

SC-1	15-01-XXXX-X,	15-01-XXXX-X,	15-01-XXXX-X
SC-2	15-02-XXXX-X,	15-02-XXXX-X,	15-02-XXXX-X
SC-3	15-03-XXXX-X,	15-03-XXXX-X,	15-03-XXXX-X

D. TRANSMISSION VERIFICATION MESSAGE (DSIF 5 ONLY)

COMMAND	INITIATE	VERIFY
SC-1	XXXXXX	XXXXXX
SC-2	XXXXXX	XXXXXX
SC-3	XXXXXX	XXXXXX

TABLE III-5. READ-WRITE-VERIFY SYSTEM CHECKOUT PROCEDURE

1. TURN ON MAIN POWER

a. Voltage Readings

1152A T/S	-16 B Voltage
	-16 A Voltage
	+16 A Voltage
Hewlett-Packard	+28 Volt Supply
1192 Power Supply	-2 Voltage
	-50 Voltage

2. CHECKOUT PREPARATIONS

a. The line driver output to the transmitter should be opened to insure that the RWV does not modulate the transmitter during the system checkout. The RWV must now be connected for closed loop operation. This is done by placing a jumper between G-8 and H-8 on the patch panel (see Table III-7). The pseudo noise code can be observed at D-8 of the patch panel.

Note: Depress Error Switch when making any mode change except "Initiate System in Process".

b. Emergency-Normal switch to Normal

c. Key - full clockwise

d. Mode Switch to Mode I

3. TEST TAPE PREPARATIONS

a. Mode Switch, Mode I

b. Select the following numbers on the thumb wheels and perforate a test tape by depressing the "Manual Perforate" switch three times for each test word.

Test Words

Test Word 1	Start	Decoder Address	CC&S Address	Magnitude	Polarity
Binary	1	0101010	10101	010101010101	0
Octal	1	052	25	2525	0
Test Word 2					
Binary	1	1010101	01010	101010101010	1
Octal	1	125	12	5252	1

Note: The start bit precedes the address and is automatically inserted (Fig. III-1).

TABLE III-5. READ-WRITE-VERIFY SYSTEM CHECKOUT PROCEDURE (Cont'd)

c. Load tape in reader (leave system in Mode I).

d. Initiate "System in Process".

1) The first test word will readout on storages A, B and C successively.

2) Display lines A, B and C will show the same Octal form which was set in the thumb wheels.

3) Repeat for each test word.

This is a quick check to insure that the words selected on the thumbwheels are the same words as on the tape.

4. SYSTEM CHECKOUT

a. Re-load test tape into tape reader.

b. Change mode switch to Mode II.

c. Bit sync synchronization.

1) Insure that the oscillator switch is in the external position.

2) Transmit light on (insure that modulation line is open between RWV and Transmitter).

3) Set verify switch to "Internal".

4) Synchronize modulator and detector bit sync by connecting the oscilloscope External Sync Input to B-7 on patch panel (Modulate Bit Sync) and connecting the vertical input to E-7 on patch panel (Detector Bit Sync).

5) Adjust Burr-Brown oscillator output frequency above $8f_s$ until the displayed pulse (Detector Bit Sync) moves into lock. Lock is indicated by the out of lock (red) light going out. When lock is acquired bring the oscillator frequency back slowly to the nominal $8f_s$. The ground sync light will now be illuminated.

6) Spacecraft VCO data may be simulated by locking the demodulator and decommutator and the telemetry simulator. The VCO display may be changed by changing the binary word injected by the simulator.

d. Initiate system in process.

1) Word is read-out at storage "A".

2) Twenty-six seconds after system start, the word is then read-out at storage "B".

3) Storage A, B and C will compare.

e. Switch to "Emergency" and preselect test word "one" on the data scanner.

1) Preset data scanner.

2) Start data scanner.

3) Yellow light on data scanner lights for a Binary "1".

4) Repeat for test word "two"

TABLE III-6. COMMAND TRANSMISSION PROCEDURES

1. SPACECRAFT INTEROGATION COMMAND

a. Connect line driver output to transmitter.

b. Adjust amplitude to previously determined level to give proper modulation index.

c. With transmitter on, lock up the RWV receiver and zero out the static phase error. The signal strength should be between -30 dbm and -50 dbm.

d. Obtain bit sync as follows:

1) Check that verify switch is in "Internal" position.

2) Synchronize the modulator and detector bit sync by connecting the oscilloscope "External Sync" input to B-7 on patch panel (Modulator Bit Sync) and connecting the vertical input to E-7 on patch panel (Detector Bit Sync).

3) Adjust Burr-Brown oscillator frequency above $8f_s$ until the displayed pulse (Detector Bit Sync) moves into sync. Lock is indicated by the out-of-lock light going out.

e. Obtain spacecraft sync as follows:

1) Insure that the telemetry demodulator and decommutator are in sync.

2) Observe the spacecraft VCO display. Decode the frequency difference.

3) Set the Burr-Brown oscillator approximately 4 cps above the indicated spacecraft VCO frequency. (The VCO reading is held "On" until the new reading is sampled. The sample rate is once per 32 seconds at the 8 bit per second data rate).

4) Observe the VCO drift rate. The VCO should lock to the ground sync signal when the VCO stops drifting at the frequency of the ground oscillator. Note: The VCO indication is the $2f_s$ frequency, the Burr-Brown oscillator is at the $8f_s$ frequency.

5) Once the spacecraft VCO has locked to the ground oscillator, the "Vehicle Sync" light will come on.

6) Adjust the Burr-Brown oscillator to the nominal frequency.

f. Verify the validity of the command to be sent.

1) Use verify sub-mode.

2) No readout will be present at storage "C".

g. Place emergency - Normal switch in Normal.

h. Load tape in tape reader.

TABLE III-6. COMMAND TRANSMISSION PROCEDURES (CONT.)

i. Place mode switch to Mode II.

j. Place transmit-verify switch to Transmit.

k. Inter word delay - 1 second.

l. Word stop - 1.

2. EMERGENCY

a. Switch from Normal to Emergency.

b. Insert Octal presentation of command word with panel switches.

c. Initiate "Preset Switch".

d. Initiate "Start Switch".

e. Observe bit light that the command is being transmitted.

TABLE III-7. PATCH PANEL INDEX FOR GROUND INSTRUMENTATION SYSTEM

A2	+12 - A-24-Z	E2	Mod $8F_s$ C-12-C
A9	-12 - A-24-A	E3	Mod Prim $8F_s$ C-3-E
B2	Det Amp - B-21-V	E4	Mod $4F_s$ C-17-T
B3	VCO In - B-21-B	E5	Mod $2F_s$ C-17-S
B4	VCO Out - B-21-D	E6	Mod Bit Sync B-26-B
B5	Det $2F_s$ - B-12-F	E7	Mod Bit Sync B-26-D
B6	Det F_s - B-25-Y	E8	Mod $\overline{PN}$ - B-11-C
B7	Det Bit Syn - B-13-R	E9	Mod PN - B-11-E
B8	Det $\overline{PN}$ - B-3-V	*F5	Mod Output (before inverter) C-23-V
B9	Det PN - B-3-Y	F6	Mod Out - C-14-H
C2	GND Sync - C-21-S	F7	Comm $2F_s$ - C-14-P
C3	Det Out C-19-E	F8	Sync Mod - C-10-B
C4	Det Comm Limiter - B-26-W	F9	Ext $8F_s$ - B-24-U
C5	Det Comm $2F_s$ - C-26-C	**G8	To Transmitter (BNC #9)
C6	Det In C-23-R	G9	Mod Input C-14-L
C7	Det Syn Filter In B-18-T	H2	OSC Input
C8	Det Sync Filter Out B-18-C	H3	Ext F_8 Input
C9	Det Sync Limiter Out B-20-T	**H8	Mod Input (after inverter)
D7	Ex PN B-26-K	I 2	+28 V A-24-T
D8	Rec In C-22-J	I 5	Counter
D9	VT Cont C-21-X	J 1-10	GND

* F-5 and G-8 jumpered provides no modulation inversion (abnormal mode).

**Jumper G-8 and H-8 for closed loop operation (remove modulation to transmitter).

(CCF) during the mission and transmitted to the DSIF stations via DSIF Net Control. A command verification procedure will be followed to insure that accurate command transmission and compliance is obtained.

1. Transmission of Commands to DSIF Stations

Teletype messages will be used to transmit the command information from Net Control to a DSIF station. In the case of the midcourse maneuver these command information messages will give:

1) The three required stored commands each repeated three times.
2) The times, each repeated three times, at which the real time command for the antenna switchover and the real time command for the maneuver initiation should be transmitted.

The format of this teletype message is given in Table III-4, along with the formats used in the transmission of the other types of command information messages.

2. Verification of Commands Prior to Transmission to the Spacecraft

After the command information message is received at a DSIF station a series of verification procedures are initiated to insure accurate command transmission. The station manager acknowledges verbally via teletype or by telephone:

1) Receipt of the message.
2) Command numbers (octal presentation).
3) Command execution time.

In the case of messages containing stored commands which are to be transmitted to the spacecraft, a duplicate of the command message is made on the teletype reperforator and is then transmitted to Net Control for verification. Net control will verbally inform the DSIF station of verification.

In the case of real time commands, which are available at the DSIF station on prepunched tapes, only the acknowledgement and confirmation of the station manager's verbal report is required prior to transmission to the spacecraft. In the case of stored commands additional verification procedures are performed. After being thoroughly checked (see Table III-5) the Read-Write-Verify (RWV) system is used to verify the stored commands to be transmitted to the spacecraft. The RWV system is also used to modulate the transmitter when commands are transmitted to the spacecraft.

When the proper operation of the RWV system has been ascertained each group of three identical commands will be read into the RWV system, verified, and a command tape "cut". The RWV system will provide a display of the octal interpretation of each command,and for each group of identical commands these displays will be checked for agreement among themselves and with the octal interpretation received from Net Control. These octal displays should also be verbally reported to Net Control. Additionally DSIF 5 will send a command verification message by teletype (see Table III-4).

As each group of identical command words is verified, the octal command interpretation is set on the RWV system thumbwheels and the command word punched on a paper tape. At the conclusion of the verification of the teletyped command words, this paper tape will then contain sequentially one of each of the stored commands which were verified (see Table III-3). This tape is then read into the RWV system and the octal interpretation of each command word checked.

3. Transmission of Commands by the DSIF

The same procedure will be used in transmitting real time and stored commands (see Table III-6). The command tape, either the prepunched real time command or the verified stored command tape from the RWV unit, is fed into the RWV system. At the proper time (nominal command transmission times are given in Table VII-2) the command will be initiated and will begin its transmit cycle which also includes a verify mode. If the RWV detects loss of S/C sync or some error, either in the command or the RWV circuitry, the command transmission will be inhibited. There is an emergency mode which can be used, however, if it is desired or necessary to transmit a command without using the verify mode of the transmit cycle.

After successful command transmission the station manager will notify Net Control via telephone of the command transmitted and the transmission time. Additionally, DSIF 5 will send a transmission verification message (see Table III-4). The station manager will also include this information in the next teletype station report.

E. TELEMETRY LOCK-UP PROCEDURE

1. Prior to Acquisition

a. Connect pole beacon modulator output to demodulator input.

b. Set modulator bit rate to expected bit rate during track.

c. Place mission switch to proper mission indication (see Table III-8) and set the transmitter-demodulator switch to demodulator. Set the internal-external switch to internal.

d. Place demodulator switches to following:

1) Data Rate - Appropriate expected bit rate.

2) PN Drive - Sync.

3) Sync-Data Phase-Error - $4f_s$.

e. Acquire Data Loop - Adjust VCO for "0" loop amplifier switch to narrow bandwidth.

f. Acquire Sync Loop - Adjust VCO until either "S" curve is indicated on phase error meter or sync-data phase-error rate indicates lock.

g. Follow procedure in demodulator manual for adjustment of sync-data phase relationship.

h. Once demodulator is locked-up place SW-10 in the "up" position (located inside-bottom of chassis). Place oscilloscope test probe in TP-30 sync loop phase detector (located on right side of chassis). Adjust the sync filter frequency until waveform is symmetrical. Place external sync oscilloscope probe on internal word sync, TP-48.

i. Place SW-10 in down position. Adjust data filter frequency until waveform is symmetrical.

j. Set PN drive to data position, if not in position already.

2. After RF Acquisition

a. Remove demodulator input from pole beacon modulator, connect to receiver output. Adjust signal input level to approximately one volt RMS (signal plus noise).

b. Place oscilloscope monitor in TB-31 (sync loop filter output). This will aid acquisition of sync loop. The VCO fine adjust will control the waveform. When the sync loop is locked to the proper signal (there are several false lock positions) the waveform will resemble a saw tooth, corrupted by noise.

c. Adjust data loop until phase error is symmetrical about zero.

d. Adjust VCO frequency control until the loop amplifier output is zero. Set PN drive switch to DATA position.

e. Monitor data output to decommutator (TP-2); there should be one word consisting of all ones (address A0) on every frame. If the data is inverted (i.e., sync word is all zeros) switch S-20 (located inside-bottom of chassis) to opposite position. As the decommutator will not cycle on inverted data, non-operation of the decommutator is a good indication that the decommutator is being fed $\overline{\text{DATA}}$ (inverted) and not DATA.

TABLE III-8. TELEMETRY TO TTY ENCODER MISSION SWITCH POSITION

IMPORTANT

THE TELEMETRY TO TTY ENCODER MISSION SWITCH SHOULD BE PLACED TO POSITION 1 WHEN TRACKING THE FIRST MARINER R AND TO POSITION 2 WHEN TRACKING THE SECOND MARINER R

SECTION IV

MODES OF OPERATION

A. SPACECRAFT MODES

The spacecraft modes are defined according to flight periods and have been assigned identification according to the telemetry system mode for that portion of the mission. Changes in the telemetry system mode are accomplished by the Central Computer and Sequencer (CC&S) in the spacecraft, or in the event of a mode change malfunction, by command from the DSIF.

Mode I Launch to Earth Acquisition - duration, 167 hours. Identified by engineering telemetry transmission at the 33 bits per second data rate.

Mode II Cruise Mode - duration, earth acquisition to encounter minus 10 hours. Identified by multiplexed transmission of telemetered engineering and scientific data at the 8 bits per second data rate.

Mode III Planetary Encounter - duration, 66.7 hours. Identified by only science data being transmitted at the 8 bits per second data rate.

NOTE: After planetary encounter plus 66.7 hours the spacecraft will be returned to Mode II, the cruise mode.

B. GROUND STATION MODES

The eight modes of operation of the DSIF are identified as Ground Modes (GM) and are defined as follows:

GM-1 Tracking the 960.05 mc/s transponder signal in the two-way mode and obtaining angles, two-way doppler, and spacecraft telemetry. This mode is possible at DSIF 1, DSIF 4, and DSIF 5.

GM-2 Listening for the 960.05 mc/s transponder signal in the two-way mode and obtaining two-way doppler and spacecraft telemetry. This mode is possible at DSIF 5 (with 10 KW diplexer) or at the combination DSIF 2 and 3 sites.

GM-3 Tracking the 960.05 mc/s transponder signal in the one-way mode and obtaining angles, one-way doppler, spacecraft telemetry.

GM-4 Listening for the 960.05 mc/s transponder signal in the one-way mode and obtaining one-way doppler and spacecraft telemetry.

GM-5 Tracking the 960.1 mc/s transponder signal in the two-way mode and obtaining angles, two-way doppler spacecraft telemetry. This mode is possible at DSIF 1, 4, and 5.

GM-6 Listening for the 960.1 mc/s transponder signal in the two-way mode and obtaining two-way doppler and spacecraft telemetry. This mode is possible at DSIF 5 (with 10-kilowatt diplexer) or at the combination DSIF 2 and 3 sites.

GM-7 Tracking the 960.1 mc/s transponder signal in the one-way mode and obtaining angles, one-way doppler, and spacecraft telemetry.

GM-8 Listening for the 960.1 mc/s transponder signal in the one-way mode and obtaining one-way doppler and spacecraft telemetry.

C. DSIF STATION CONFIGURATIONS

After injection as the spacecraft travels in its orbit, the space loss involved in the RF link changes thereby changing the received signal level at the DSIF stations; therefore the configuration of the DSIF stations will be changed as a function of time so that requirements of the mission will best be met.

The station configurations will be as follows:

1. Goldstone

   a. Launch to L + 2 days

      1) DSIF 3 Tracking feed, 200 W transmitter
      2) DSIF 2 Two-way doppler - listening feed

   b. L + 2 days to end of mission

      1) DSIF 3 Transmitting feed, up to 10 KW transmitted

      2) DSIF 2 Two-way doppler - listening feed

2. Johannesburg

   a. Launch to L plus 2 days

      1) DSIF 5 Tracking feed, 200 W transmitter

   b. L plus 2 days to (X)*

      1) DSIF 5 Transmitting feed, up to 10 KW transmitted (adjusted for acceptable receiver performance)

* The DSIF 5 configuration is very closely related to the transmitter figure of merit. At some time near the end of the mission the quality of the doppler may become so poor that DSIF 5 will use only a listening feed.

3. Woomera

a. Launch to L plus 2 days

1) DSIF 4 Tracking feed, 50 W transmitter

b. L + 2 days to near end of mission**

1) DSIF 4 Tracking feed, no transmitter

c. Near end of mission** to end of mission

1) DSIF 4 If tolerances are all negative it may be necessary to change to a listening feed.

D. OPERATIONAL READINESS TEST PROCEDURE

Two operational readiness tests will be performed. See Section VII-B for the test schedule and sequence of events. These tests will simulate as closely as possible the actual operating conditions and procedures. Prior to participation in these tests and before the simulated launch time, all stations will perform a complete pre-launch station checkout. At the scheduled acquisition time the stations will acquire the collimation tower and autotrack the test transponder. Auto-tracking of the collimation tower will allow simulation of the system operation and will allow the normal tracking mission performance recording to be done. During these tests all data to be recorded during the actual mission will be recorded. The tracking data transmitted will, however, be the pre-recorded tracking data that has been supplied to the station. The first point on the tape will be transmitted at the simulated acquisition time. Care will be taken by all stations to transmit this tracking data in as near real time as possible.

** Determined by Net Control based on conditions of the spacecraft and DSIF 4 ground equipment.

All normal recordings and recording procedures (see Section V) will be followed except for magnetic tape recording at DSIF 1, 3, 4, and 5, where one tape recorder will be used to play the pre-recorded telemetry tape. The telemetry simulation procedure at DSIF 1, 3, 4, and 5 will be:

1) Tape machine B will be used to play the pre-recorded telemetry test tape at 60 inches per second. Test tape track assignments are:

Track	Function	Type of Recording
1	Test Director, Voice	Direct
2	- Blank -	
3	NASA Timing, Flutter Compensation Tone	Direct
4	100 KC Reference	Direct
5	Composite Telemetry	Direct
6	Data Lab, Voice	Direct
7	Composite Telemetry	Direct

NOTE:
1) Track designations are IRIG Standard.
2) The telemetry demodulator will be connected to Track 5 output.
3) Load the proper tape on machine B. The test tapes are identified by numbers which correspond to specific time in the sequence of events.
4) At indicated time, start machine B, lock-up the demodulator and sync the decommutator.
5) Tape machine A will be used to record the tracking system data normally recorded.

The data outputs of the teletype encoder will be transmitted by teletype to Net Control according to the schedule given in Table VII-2 and VII-3. At the conclusion of the Operational Readiness test, the data will be shipped to JPL in the normal manner.

SECTION V

DATA HANDLING AND RECORDING

A. PREDICTION DATA

Prediction data will be supplied to the DSIF stations from two sources: the computing facilities at AMR and the Central Computing Facility (CCF) at JPL. From launch to injection the AMR computer will do the primary computation and the CCF will do a backup computation. After injection the CCF will be the prime computer and will provide all prediction data for the DSIF stations. Figure V-1 shows the prediction data flow from the CCF to the DSIF stations. Figure V-2 shows the format of the prediction data.

Figures V-3 (DSIF 1) and V-4 (DSIF 3, 4, and 5) present the one-way doppler detector output frequency correction factor.

B. TRACKING DATA

During the tracking mission the data handling system settings will be varied to obtain various tracking data sample rates and doppler count intervals. The data handling system settings, tracking data formats, data condition code interpretation and doppler reference frequencies are given respectively in Tables V-1 and V-2, Table V-3 and V-4, Table V-5, and Table V-6. The schedule of the variation of the sample rate with time from injection and the schedule of data handling system settings are both given in Section VII-E.

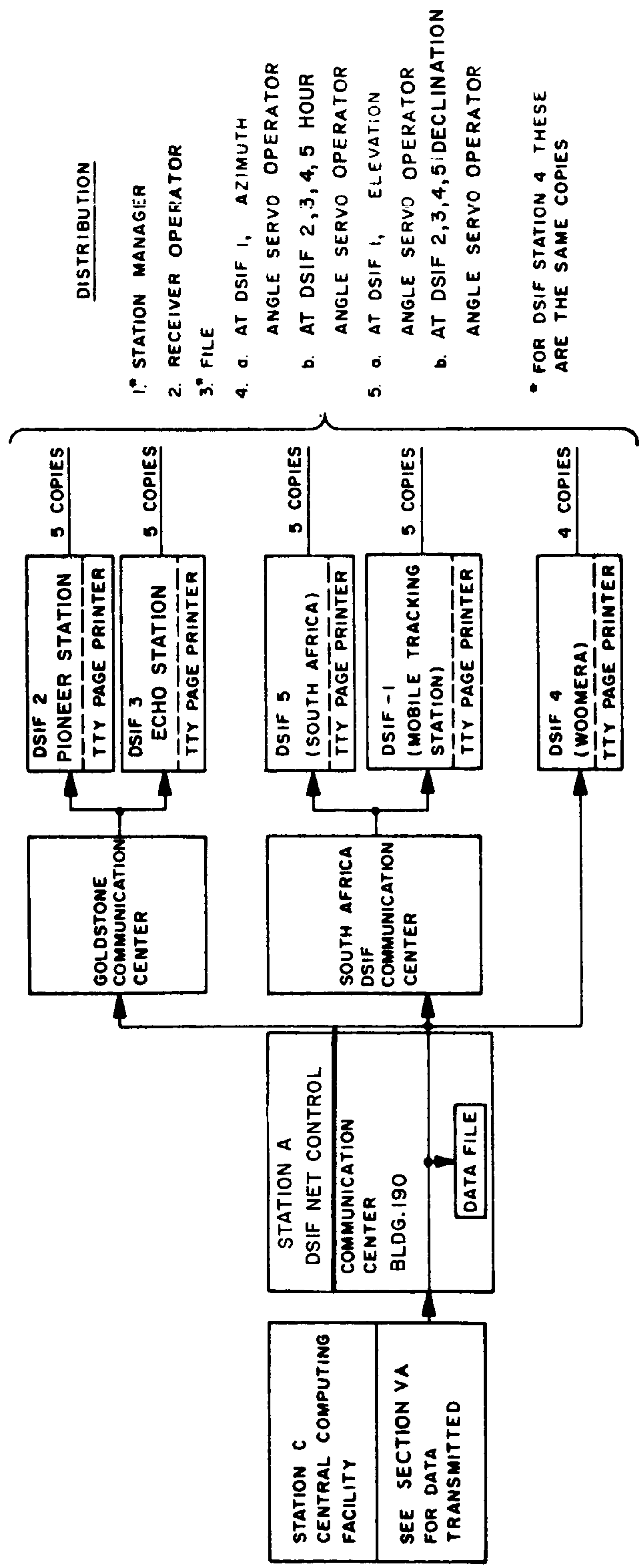


Figure V-1. DSIF Prediction and Acquisition Data Flow

AMR Prediction Data Format 1)

H	M	S	AZ	EL	D_1	HA	DEC	D_2	M.N.
XX	XX	XX	XXXXX	XXXXX	XXXX	XXXXX	XXXXX	XXXX	XXXX

CCF Prediction Data Format 2)

ID	TIME	HA	DEC	D_{1i}	D_{2i}	DAY OF YEAR
X	XXXXXX	XXXXXX	XXXXXX	XXXX	XXXX	XXX

Notes:

1) For the AMR prediction data format:

a. The format shown is for DSIF-1 and -5. The format for DSIF-4 will be similar except that HA and DEC will be substituted for AZ and EL respectively.

b. D_1 and D_2 are the one-way and two-way doppler detector output frequencies in cps. See Appendix F for the applicable equations.

c. H M S is GMT in hours, minutes, and seconds. Pointing angles are given in hundredths of degrees. M.N. is the message number and has no significance to the DSIF.

2) For the CCF prediction data format:

a. The format shown is for DSIF-2, 3, 4, and 5. The format for DSIF 1 is similar except AZ and EL replace HA and DEC respectively.

b. D_{1i} and D_{2i} are the doppler detector output frequencies in cps for the "i"th station. See Appendix F for the applicable equations.

c. TIME is GMT in hours, minutes, and seconds. Pointing angles are given in thousandths of degrees.

d. The prediction data message will include, before the data listing, the range at the first and last data point and the transmitter frequency, f_t, used in computing D_{1i}.

Figure V-2. DSIF Prediction Data Formats

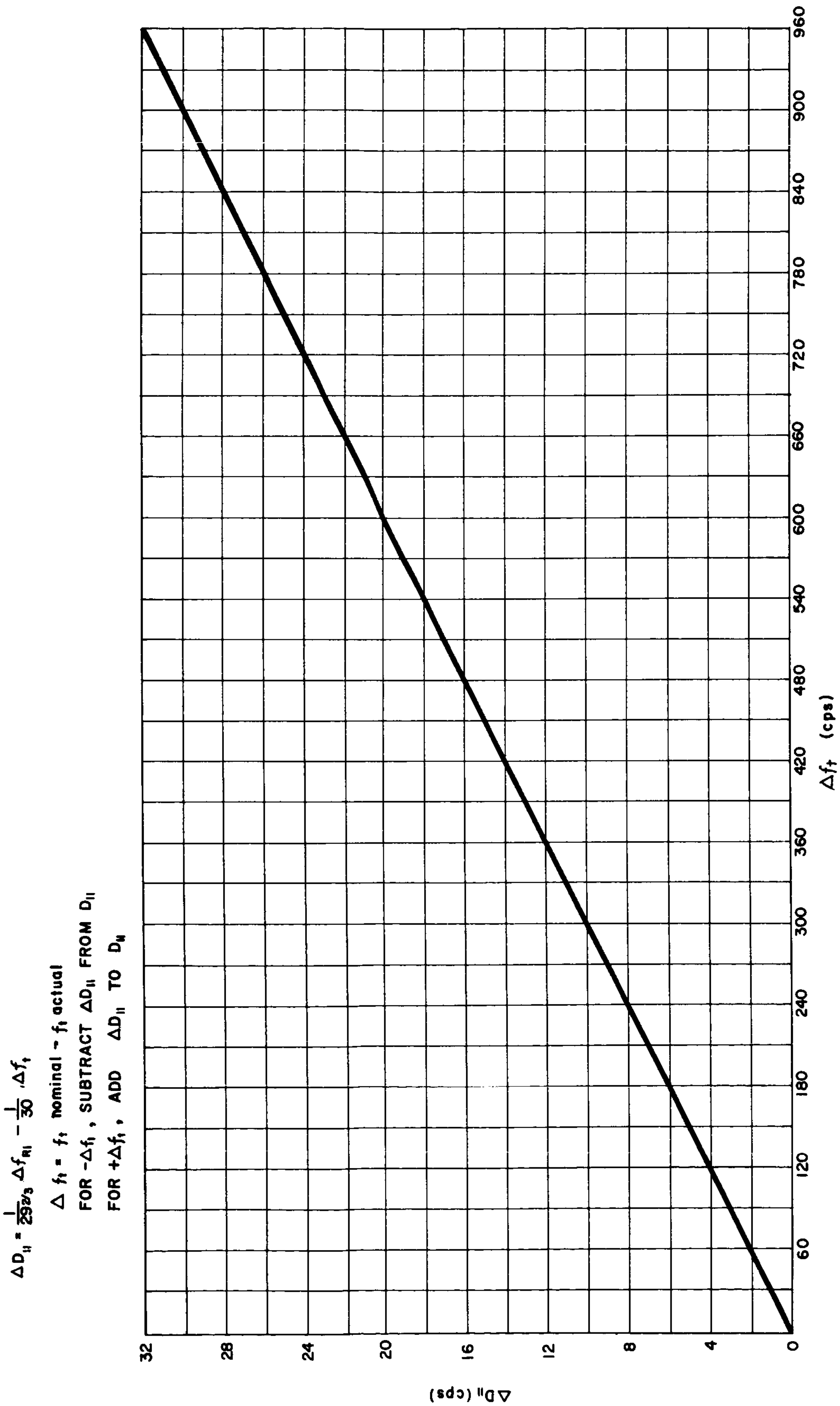


Figure V-3. One-Way Doppler Detector Output Frequency Correction Factor ΔD_{11} (DSIF 1)

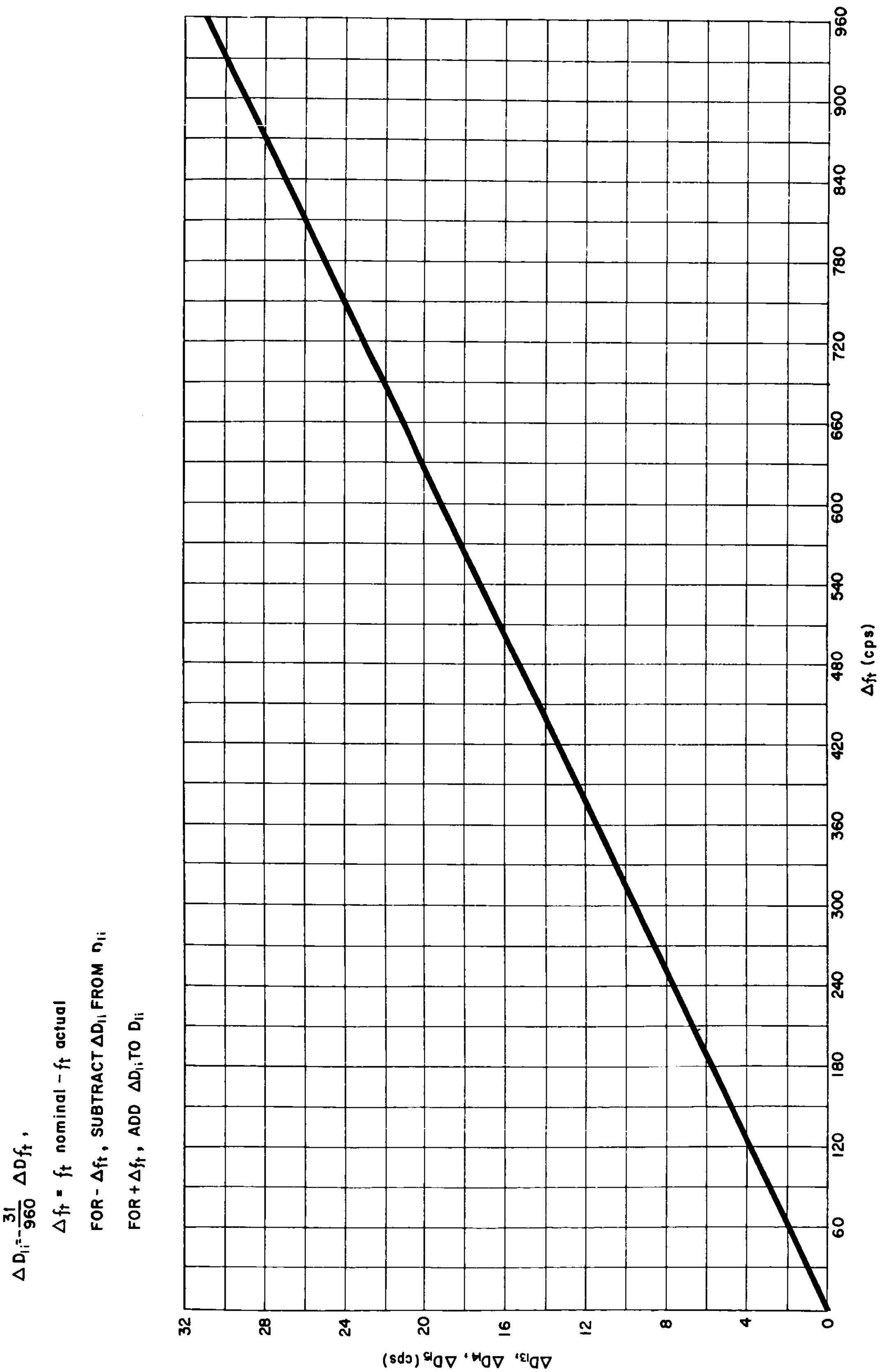


Figure V-4. One-Way Doppler Detector Output Frequency Correction Factor $\Delta D_{13,\ 14,\ 15}$ (DSIF 3, 4, 5)

TABLE V-1. DATA HANDLING SYSTEM SETTINGS AT DSIF-1

1. SAMPLE INTERVAL:

Sample Interval (sec)	Record Interval Switch Position	Record Multiplier Switch Position
1	1 sec	1
10	10 sec	1
20	10 sec	2
30	10 sec	3
60	1 min	1

2. PUNCH TAPE FEED: Off

3. COUNTER INPUT: Doppler

4. DOPPLER COUNTER:

   Destructive Count - Frequency Counter
   Nondestructive Count - Nondestructive Counter

TABLE V-2. DATA HANDLING SYSTEM SETTINGS
AT DSIF STATIONS -2, -3, -4, AND -5

1. RECORD MODE: Single Punch

2. SAMPLE INTERVAL:

Sample Interval (sec)	Record Interval Switch Position	Record Multiplier Switch Position
1	1 sec	1
10	10 sec	1
20	10 sec	2
30	10 sec	3
60	1 min	1
120	1 min	2

3. MASTER PUNCH TAPE FEED: Off

4. DOPPLER COUNT MODE SWITCH POSITION:

   a. Destructive Count (Doppler Count Period Less Than System Sample Interval): Counter #1 (Counter #2 to be used only if failure in Counter #1)

   b. Destructive Count (Doppler Count Period Identical to System Sample Interval): Alternate

   c. Nondestructive Count: Continuous Mode (Full Clockwise Position)

5. COUNTER INPUT SWITCH POSITION: Doppler

6. DOPPLER COUNT PERIOD SWITCH POSITION:

   a. Destructive Count: See Section VII-E

   b. Nondestructive Count: 1 sec Position (Counter Operates Continuously. Sampling Controller by System Sample Interval. See Section VII-E)

7. TIME AND ANGLE SAMPLE: End of doppler count period

8. DOPPLER WORD LENGTH: Seven Digits When Operating in Destructive Count Mode. Ten Digits When Operating in Nondestructive Count Mode. (See Section VII-E)

TABLE V-3. TRACKING DATA RECORDING AND TELETYPE TRANSMISSION FORMATS [1] FOR DSIF-1

1. PAGE PRINT FORMAT

STA ID	DCC [2]	GMT HR MIN SEC	AZIMUTH 0.001 DEG.	ELEVATION 0.001 DEG.	DOPPLER CPS	DAY OF YEAR
1	00	163042	321322	035214	13214223	113

2. TELETYPE TAPE FORMAT

Carriage return	1
Line feed	1
Figure shift	1
Station identification	1 digit
Space	1
Figure shift	1
Data Condition code	2 digits
Space	1
Figure shift	1
Time	6 digits
Space	1
Figure shift	1
Azimuth Angle	6 digits
Space	1
Figure shift	1
Elevation Angle	6 digits
Space	1
Figure shift	1
Doppler Count	8 digits
Space	1
Figure shift	1
Day of Year	3 digits
Space	1

1) See Section VI for teletype address formats

2) Data Condition code

TABLE V-4. TRACKING DATA TELETYPE FORMATS FOR DSIF STATIONS 2, 3, 4 AND 5

1. PAGE PRINT FORMAT [1)]

STA ID	DCC [2)]	TIME HR MIN SEC	HA 0.001 DEG	DEC 0.001 DEG	DOPPLER CPS	DAY OF YEAR
3	00000		104000	037214	1321422 [3)]	161

2. TTY TAPE FORMAT [1)]

Carriage return	1 digit
Line feed	1
Figure shift	1
Station ID	1
Space	1
Figure shift	1
Data Condition code	5 digits at DSIF 2, 3
Data Condition code	4 digits at DSIF 4, 5
Space	1
Figure shift	1
Hour angle	6
Space	1
Figure shift	1
Declination	6
Space	1
Figure shift	1
Doppler count	7 [3)]
Space	1
Figure shift	1
Day of year	3

1) The formats for all stations are similar. Since DSIF 4, 5 do not have the atomichron " in lock", "out of lock", digit in the DCC for these stations.

2) Data Condition Code.

3) Ten digits will be used when in the nondestructive doppler count mode (see Section VII-E).

TABLE V-5. [1] INTERPRETATION OF THE DATA CONDITION CODE USED AT THE DSIF STATIONS

1. FIRST CODE DIGIT (not used at Mobile Tracking Station)

The first digit of the DCC gives the doppler averaging time. The code is:

CODE DIGIT	AVERAGE TIME (sec)
0	1
1	5
2	10
3	20
4	30
5	40
6	50
7	60
8	CONTINUOUS [2] COUNT

2. SECOND CODE DIGIT (first digit at Mobile Tracking Station)

The second (first at Mobile Tracking Station) code digit indicates the station tracking condition, and the code used is:

CODE DIGIT	ACQUISITION SWITCH	ACQUISITION CONTACTS	ANTENNA MODE
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

1) Table V-5 continued on next page

2) For nondestructive counting

TABLE V-5. INTERPRETATION OF THE DATA CONDITION CODE USED AT THE DSIF STATIONS (Cont'd)

Where 0 and 1 are "flip-flop" states which indicate:

	"0" State	"1" State
Acquisition switch "Normal"	Good Data	Bad Data
Acquisition contacts	In RF lock and doppler multiplier in lock	Out of RF or doppler multiplier out of lock
Antenna mode	Auto track	Not in auto track

3. THIRD CODE DIGIT (second digit at Mobile Tracking Station)
The third (second at Mobile Tracking Station) code digit indicates, for the doppler data, the counter used and the type of doppler recorded. The code digits indicate:

CODE DIGIT	COUNTER RECORDED 3)	ONE-WAY DOPPLER	TWO-WAY DOPPLER
0	0	0	0
1	0	0	1
2	0	1	0
3	- NOT		-USED
4	1	0	0
5	1	0	1
6	1	1	0
7	- NOT	1	-USED

3) Except for DSIF-1, during nondestructive counting counter No. 2 will be used as a storage register and therefore its reading will be recorded. Counter No. 1 will, however, actually be the operating counter. Since DSIF-1 only uses one counter, the code digit will always indicate counter No. 1 being recorded and therefore will only be 0, 1 or 2.

TABLE V-5. INTERPRETATION OF THE DATA CONDITION CODE USED AT THE DSIF STATIONS (Cont'd)

The 0 and 1 are "flip-flop" states and indicate:

COUNTER RECORDED	STATE	DOPPLER RECORDED	STATES	
No. 1	0	Two-Way	0	0
No. 2	1	One-Way	0	1
		Pseudo Two-Way	1	0

4. FOURTH CODE DIGIT

The fourth code digit is the mission designator and it indicates the spacecraft or mission to which the tracking data applies. This number will change sequentially for each mission supported by the DSIF.

DESIGNATOR	MISSION
0	First Mariner R
1	Second Mariner R

5. ATOMIC FREQUENCY STANDARD "IN-LOCK", "OUT OF LOCK"

The fifth code digit is used only at the Goldstone Stations, DSIF-2 and -3. It indicates whether the Atomic frequency standard, used for transmitter frequency control, is in or out of lock.

DIGIT	ATOMIC FREQUENCY STANDARD STATE
0	In Lock
1	Out of Lock

TABLE V-6. DOPPLER REFERENCE FREQUENCIES USED AT THE DSIF STATIONS

DSIF Station	Reference Frequency
1	One-way operation - 31.0050 mc/sec 1) Two-way operation - see note 2)
2	31.0100 m/sec 3)
3	One-way operation - 31.0050 mc/sec 1) Two-way operation - see note 2)
4	One-way operation - 31.0050 mc/sec 1) Two-way operation - see note 2)
5	One-way operation - 31.0050 mc/sec 1) Two-way operation - see note 2)

1) Obtained in the receiver using 31.0000 mc/sec from the Gertsch Frequency Multiplier and the 5.0 kc/sec bias frequency.

2) The reference frequency is obtained from the transmitter VCO and the 33.3 kc/sec bias frequency.

3) Obtained from the Gertsch Frequency Multiplier.

C. TELEMETRY DATA TRANSMITTED IN NEAR REAL TIME

Telemetry data, for specified sampling periods (see Table V-7), from DSIF 3, 4, and 5 will be transmitted in near real time to the JPL SFOC. During the portion of the mission when data is received from the S/C at the 33 bit/sec rate, a certain amount of punched tape accumulates since the TTY transmission is at a fixed 6 bit sec rate. When the S/C is in the cruise mode the data transmission rate is at 8.3 bit/sec and the TTY transmission is nearer to real time.

All the telemetry data is recorded on magnetic tape and the tapes are sent to JPL as per instructions.

D. STATION REPORTS

DSIF stations will report both events at the station and S/C events, as indicated by telemetry. The formats and the type of information required are indicated in the following paragraphs. A Transmission Priority Schedule is given below. Information with the highest priority is listed first.

1) Telemetry data from the telemetry to TTY encoder
2) Tracking data
3) Station reports

1. Reports Prior to Launch

Daily station status reports will be submitted to Net Control from each DSIF station during the ten days prior to launch. These station reports will give the station conditions, station readiness, and system test progress.

2. Pretracking Period Report

Prior to a station tracking period a report will be submitted to Net Control giving:

a. Receiver threshold
b. Boresight shift

TABLE V-7.[1] INFORMATION AND FORMAT REQUIRED FOR STATION REPORTS

Item	Information
XP1[2]	Last 5 digits of VCO frequency (10 second count), GMT and day of year every 5 minutes through I + 10 days, then once every 15 minutes.
2.[4]	Start and/or end time of the ground station tracking mode.
3.	The average signal level, any variation about this level and the GMT of the signal level reading.
4.	The telemetry condition.
5.	Equipment failures and time of occurrence.
6.	If tracking in the off frequency configuration, the bias oscillator frequency (30.5065 mc/s) and the 455 KC/s reference oscillator frequency.
7.	The transmitter power (dbm for DSIF 1, watts for DSIF 3, 4 and 5).
8.[3]	Time (GMT) of significant events. For example:
	a. Time of acquisition.
	b. Time of loss of signal.
	c. Time of significant changes in the tracking system (e.g., receiver and servo bandwidth changes.
	d. Time of abrupt frequency shifts.
	e. Time of changes in signal level corresponding to spacecraft events or commands.
	f. Time of command transmission.
	g. Time of verification of command transmission.

TABLE V-7. [1] INFORMATION AND FORMAT REQUIRED FOR STATION REPORTS (Cont'd)

SAMPLE STATION REPORT

Example: Station Report from DSIF 3, two days after launch, tracking the first MR, time of report 1605Z.

PP JETLAB
DE JETGLD 3
P 271625Z
BT
OPS X
STATION REPORT

STA 3	1600Z	0	208
3P1	82135	150530Z	208
3P1	82134	151030Z	208
3P1	82137	151530Z	208
3P1	82134	152030Z	208
3P1	82136	152530Z	208
3P1	82157	153030Z	208
3P1	82164	153530Z	208
3P1	82164	153530Z	208
3P1	82165	154030Z	208
3P1	82168	154530Z	208
3P1	82167	155030Z	208
3P1	82168	155530Z	208
3P1	82167	160030Z	208

2. 132210Z
3. -141 dbm, steady 154504Z
4. In lock
5. None
6. N/A

TABLE V-7. [1] INFORMATION AND FORMAT REQUIRED FOR STATION REPORTS (Cont'd)

7. 9.25 KW
8. a. Acquisition at 150340Z.
   b. loss of signal 160430Z.
   c. Changed receiver bandwidth to 60 cps at 154506Z.
   d. 30/29 2/3 frequency shifter momentarily out of lock at 151230Z.
   e. Changed transmitter VCO frequency at 152833Z to 29.6682164 mc/s.

BT
27/1626Z JULY JET GLD 3 AB

NOTE:

1) An introductory heading should precede each station report. This heading should state: Station Report, I plus XXXXZ (until I + 1440 m) then by GMT, mission designator and day of year.

2) XP1 is a special address for computer recognition of VCO data. X is used in lieu of station number for the example. P indicates a periodic report. 1 indicates the item number.

3) In transmitting a station report it will be sufficient to indicate the item being reported, except in the case of item 8, by its item number and value. Any entry in item 8 must be defined. The examples cited above under item 8 are only examples. There are other events which are not mentioned which may require reporting. Items that do not apply at a station should not be omitted but should be indicated as NA (not applicable).

4) All times, unless otherwise instructed for a particular item, should be GMT.

1) Five samples of RF boresight data
2) Five samples of TV boresight data
3) Five samples of Optical boresight data

c. Receiver and servo bandwidths

d. AGC time constant

3. Acquisition Report

a. Time of first RF lock
b. Time of auto track
c. Signal strength at acquisition
d. Significant events during acquisition

4. Station Tracking Reports *

a. Station reports will be submitted during each tracking period as follows:

1) Every 20 minutes from I to I + 1440 m.
2) After I + 1440 m, station reports will be transmitted as specified in Section VII

b. Each station report should be referenced to injection time (e.g., I + 120 m) until I + 1440 m.

c. After I + 1440 m the reference to injection time should be omitted. In place of it, GMT should be used (e.g., 0400Z).

---

* See Table V-7 for detailed information and format required for these station reports.

d. The circuits to be used for transmission of the station report are, in decreasing preference:

1) An unused teletype circuit
2) A circuit being used for tracking data
3) A circuit being used for telemetry data

5. Station Summary Reports

At the conclusion of each station tracking period a tracking summary should be submitted containing the following information:

a. Time (GMT) of acquisition.

b. Telemetry recording conditions.

c. General tracking conditions.

d. Unusual occurrences and significant events, and their GMT.

e. Time (GMT) of end of track.

f. Time (GMT) of changes in the doppler data recording condition; e.g., time of change from accumulative count to cycle count, time of change in sample period.

g. Time (GMT) when tracking was done in each of the ground station modes (i.e., GM-1, GM-2, GM-3, or GM-4).

E. RECORDING OF TRANSMITTER VCO FREQUENCY

At DSIF 1, 3, 4, and 5, the transmitter VCO frequency will be recorded using a digital printer. Frequency samples should be recorded every twenty seconds for all periods of transmitter operation using a 10 second frequency count. The resultant recorder tape should be included in the data package.

This recorder tape can also be used in preparing station reports (see Table V-11) since time labeled samples of the VCO frequency can be read for five minute intervals and times and magnitudes of frequency shifts can be noted.

F. COMPOSITE TELEMETRY SIGNAL

All DSIF stations will record the composite telemetry signal using two tape machines (see Appendix A for track assignments) designated A and B, and the recording procedure will be:

1. At the start of recording, reel 1 will be loaded on each machine (i.e., reels 1-A and 1-B).

2. Before reel 1-B is fully used, stop machine B and load reel 2 on machine B. Enough time should be allowed so that machine A does not run out of tape while machine B is being loaded.

3. Load machine A with reel 2-A when required.

4. Near the end of reel 2-B, load reel 3-A on machine A. Allow enough time so that 2-B is not exhausted before machine A is loaded and running.

5. When reel 2-B has been used, load reel 3-B.

This procedure will be followed throughout the complete mission. The station visibility period will end before reel 3-A is expended, and at the conclusion of the tracking and recording period the three magnetic tape reels (rewound) which give a complete record of the telemetry data (i.e., reels 1-A, 2-B, and 3-A) should be collected, boxed, labelled, and shipped immediately via air to the Jet Propulsion Laboratory (see Section V-J). The other reels (1-B, 2-A, and 3-B) should be retained at the DSIF station until notification is received of the reception and processing of the shipped reels at JPL. The spare reels may then be erased and reused. If the shipped reels are not received at JPL within two weeks of the shipping date, instructions will be sent via teletype for the disposition of the spare reels.

G. STATION PERFORMANCE AND QUICK-LOOK TELEMETRY DATA RECORDING

Oscillographic recorders are used at the DSIF stations to provide records for monitoring station system performance and for quick-look analysis of the information telemetered from the spacecraft. These recorders will be operated continuously during a tracking period. The recorder speeds and track and channel assignments are given in Appendix A. The station performance and telemetry records will be sent to JPL as specified in Section V-J.

H. LABELING OF RECORDED DATA

To aid in post-flight data analysis it is imperative that all recorded data are amply identified. The following labeling requirements should be used:

1. Magnetic Tape Records

Use the supplied tape reel labels, completely filled out and applied as directed in Section V-J, Shipment of Data.

2. Teletype Tape and Teletype Page Print

Standard headings should be used on all messages and should identify the type of data or the message being transmitted. If a break occurs in the transmission of tracking or telemetry data a station identification and time label should be included when transmission is resumed. (This will assist in identifying teletype tapes).

3. Recorded Data (Other Than Magnetic Recordings)

These data should be labeled with:

a. The station identification

b. The time (GMT) of the start and finish of the recording

c. The day of the year when the recording was done

d. The recording identification (i.e., if a record is part of a set of consecutive records for a view period it should be labeled as "Record X of XX").

4. Station Calibration and Checkout Sheets

These sheets should be labeled with:

a. Station identification

b. Date of recording

c. Purpose of data (i.e., precalibration, postcalibration)

d. Time (GMT) of recording

e. Name of operator

I. SHIPMENT OF DATA

During the tracking mission, two types of data shipments will be made from each DSIF station. One shipment, a rush shipment, will consist of only the three reels of magnetic tape recorded during the tracking period. The other shipment will be a delayed shipment and will contain the station checkout and calibration sheets, oscillograph and digital printer records of the station data, a copy of the station log, two copies of the teletype printed page records, and a copy of the teletype paper tape, including the scientific and engineering telemetry tapes punched during the mission. All recordings should be shipped to the Jet Propulsion Laboratory. To facilitate the shipping process, JPL will supply the DSIF station with shipping labels, shipping cartons, data labels, packing lists, and customs declaration forms. The responsibility for the packing and shipping of all data rests solely on the station manager.

1. Shipments from the Woomera and Johannesburg Stations

a. Magnetic Tape Shipment

The magnetic tape shipment will consist of three individual tape reel packages (reels 1-A, 2-B, and 3-A, see Section V-G) enclosed in their original master carton with the required labels and documentation attached. The individual tape packages consist of the tape reel inside a tape can with the can enclosed in the original two-part cardboard sleeve. The tape reels and cardboard sleeve each should have labels (JPL 0412 MAR 61) giving the DSIF station identification, the program identification, the date and the time of the start of data recording (GMT) and the modes of spacecraft and station operation during this period. The label on the tape reel should be placed on one of the radial webs and the label on the box should be placed on the outer edge of the inner portion of the cardboard sleeve. The master carton which encloses the three individual, labeled, reel packages and the shipment packing list (JPL 0414 MAR 61) should have address labels (JPL 0385 JULY 61), one on each of the two large flat carton faces, and two carton shipping labels (JPL 0413 MAR 61) also on the two large flat faces of the master carton. The customs declaration form (JPL 0403 MAR 61) should be placed in the labeled envelope with the envelope marked "Customs Declaration Form" visible, and should be taped or glued to one of the flat faces of the carton. The label (JPL 0535 JULY 61) giving the customs form location should be pasted on the other face of the carton. The carton shipping label should be filled in, giving the station identification, the spacecraft and ground station modes for which recording was done, the date of data recording (GMT), and the type of data in the data package. The properly packed, sealed and labeled package should be shipped at the end of the tracking day, by the quickest and most reliable means possible, following standard shipping procedures, to:

Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena 3, California
U.S.A.

Attn: Receiving Dept/SFOF Document Control

Teletype notification of the time and date of shipment and other pertinent information including the dates the enclosed data were recorded should be sent according to the standard shipping procedures.

b. Shipment of Other Data

In general, unless notified to the contrary, data other than the magnetic tape recordings must be shipped, by the quickest means possible, within 48 hours from the end of the tracking period during which it was recorded. Standard shipping procedures should be followed. The data cartons supplied by JPL may be used for these data, and the labeling and documentation of the shipment will be similar to that required for the magnetic tape shipment. Magnetic tape reel labels will not be required, but three address labels and three shipping carton labels should be affixed to the outside of the shipping carton. These labels give, respectively, the JPL address to which the shipment is to be sent and the station identification, the program, the GMT of the start of data recording, and the data in the package. Address labels should be placed on the top and two opposite sides of the shipping carton. A copy of the packing list should be enclosed in the shipment, and the envelope containing the completed customs declaration form should be securely attached to the outside of the package adjacent to an address label. The location of the customs form should be indicated by placing label JPL 0535 JULY 61 on the top and back sides of the shipping carton.

2. Shipment of Data from Goldstone

Data shipment from the Goldstone Station will be done by the quickest means possible (JPL airplane if available).

a. Magnetic Tape Shipment

The magnetic tape shipment will consist of three individual tape reel packages (reels 1-A, 2-B, and 3-A, see Section V-G) enclosed in their original master carton with the required labels and documentation attached. The individual tape packages consist of the tape reel inside a tape can with the can enclosed in the original two-part cardboard sleeve. The tape reels and cardboard sleeve each should have lables (JPL 0412 MAR 61) giving the DSIF station identification, the program identification, the date and the time of the start of data recording (GMT) and the modes of spacecraft and station operation during this period. The label on the tape reel should be placed on one of the radial webs and the label on the box should be placed on the outer edge of the inner portion of the cardboard sleeve. The master carton, enclosing the three individual, labeled, reel packages and the shipment packing list (JPL 0414 MAR 61), shouldhave an address label (JPL 0385 JULY 61) and a carton shipping label (JPL 0413 MAR 61) on one of its large flat surfaces. The carton shipping label should be filled out, and will give the station identification, the tracking program, the spacecraft and station modes for which recording was done, the date of data recording (GMT), and the type of data in the data package. The properly sealed and labeled package should be shipped at the end of the tracking day, by the quickest means possible.

b. Shipment of Other Data

In general, unless notified to the contrary, data other than the magnetic tape recordings may be shipped on the day following the tracking mission during which it was recorded. The data cartons supplied by JPL may be used for these data and the labeling and documentation of the shipment will be similar to that required for the magnetic tape shipment. Magnetic tape reel labels will not be required, but an address label and shipping carton label should be affixed to the outside of the shipping carton. These labels give, respectively, the JPL address to which the shipment is to be sent and the station identification, the program, the GMT of the start of data recording, and the data in the package. A copy of the packing list should be enclosed in the shipment.

J. FINAL REPORTS ON STATION OPERATIONS

Reports of station operations are requested from each station to obtain uniform reports and to expedite the preparation of the Tracking Operation Memorandum these reports should follow the outline given below. They should be submitted to B. Ostermier at the Jet Propulsion Laboratory four weeks after launch of each spacecraft.

Station reports will consist of three section as follows:

1. Prelaunch Station Preparation

This portion of the report should cover both the new equipment installed prior to the mission and the preparatory exercises performed. Reports of the preparatory exercises should cover any station evaluation tests and the station participation in net integration tests. Reports should indicate the dates and approximate times of involvement in these tests and also indicate results or evaluate station performance in these tests.

2. Station Operations During the Mission

This section should cover the first ten days of the mission and should consist of a brief discussion of the station participation and also a more detailed chronological presentation of the station's participation. The brief discussion should set forth an over-all view of what happened during each of the station's tracking periods. If, to improve tracking conditions, any special techniques were used or if any modification of equipment was done these facts should be discussed. The chronological presentation should report events such as:

a. Any significant preacquisition occurrences.

b. Acquisition and tracking conditions.

c. Changes of tracking condition.

d. Changes in tracking system parameters.

1) Receiver bandwidth.
2) AGC time constant.
3) Servo bandwidth.

e. Conditions of received telemetry signals (i.e., noisy, channels out of lock, etc.).

f. Equipment failures.

g. General comments on any of the above occurrences.

h. Conclusion of tracking.

Forms for use in preparing this chronological presentation will be supplied.

3. Equipment Operation

This section should summarize, on a system-by-system basis (i.e., servo, data handling, receiver, etc.) any equipment problems encountered during either the prelaunch or the tracking operations. Problem discussion should indicate, if known, the cause of the problem and any corrective action taken. The time of occurrence of problems during a data-taking period should be adequately identified so that, if necessary, they may be correlated with recorded data.

Any comments or questions concerning these reports should be forwarded to B. Ostermier at JPL.

SECTION VI

COMMUNICATIONS

The communications net which will be used during the MR-1 mission is shown in Fig. VI-2. Teletype lines will be the primary communication links for the mission and will be used for transmitting data from the DSIF stations to the Central Computing Facility and for passing command, acquisition, prediction, and administrative information to the stations. The voice circuits will be available for high priority real-time communications during the launch and any other critical phases of the operation. All these communication links will be monitored and controlled by DSIF Net Control. All messages pertaining to the mission will pass through or originate from Net Control.

A. COMMUNICATION LINKS

1. Data Circuits

a. Goldstone

The Communications Center will have three half duplex teletype circuits available for data transmission to or from the Echo Station. There will be two half duplex circuits between the Pioneer and Echo Stations. There will be one wideband telephone data circuit available for one-way transmission, Goldstone to JPL. These circuits will be available for full time usage as required. Data transmissions will be restricted on any one circuit to transmission in one direction only.

b. Woomera and Johannesburg

One full duplex circuit will be available to each of the overseas stations on a full time basis. A second circuit will be available to each station on a limited basis during critical periods or when primary circuits fail. Due to the necessity of utilizing radio teletype over a significant portion of the transmission path, both circuits will not be 100 percent reliable during periods of poor HF radio propagation. Therefore to gain a measure of redundancy the primary and secondary circuits have been routed over different paths. Data transmission over these circuits can take place simultaneously in both directions.

c. Mobile Tracking Station

The MTS will utilize the same teletype circuits as the Johannesburg Station.

d. Cape Canaveral

Two half-duplex circuits will be available to Cape Canaveral during the launch period. These circuits will be available for about two weeks prior to each mission and will be used for data flow between the launch complex and the JPL Communications Center.

e. Central Computing Facilities

The 7090 computer located in Building 125 will serve as the prime computer. Backup will be provided by a second 7090 located in Building 202. Data received from the DSIF stations will be fed in parallel to both computers. Computer-derived information for the DSIF stations (acquisition data, etc.) will normally be provided by the prime computer in Building 125 and, on a secondary basis, by the backup computer in Building 202.

The following circuits connect the Building 190 JPL Technical Communications Center to the Central Computing Facilities:

1) Building 190 Comm-Center Building 125 Computer:
   - 3 full duplex
   - 3 simplex, Building 190 to Building 125 only
2) Building 190 Comm-Center to 202 Computer
   - 4 full duplex
3) Building 190 Comm-Center to 202 Computer-Building 125 Computer
   - 1 half duplex party line

In addition to the above circuits there are eight monitor page printers in the SFOC. Each machine has the capability of being switched to any incoming or outgoing line. Six television cameras are focused on the teletype page printers on the incoming data lines in Building 125. These camera outputs may be viewed by any of ten TV monitors located in the Building 125 SFOC.

f. Public Information Office

One teletype circuit will connect the Public Information Office with the JPL Communications Center.

2. Voice Circuits

a. Goldstone

Two voice circuits will be available to Goldstone. These circuits will be four wire telephone circuits capable of being conferenced at the Building 125 SFOC with other voice circuits used as part of the DSIF operations.

b. Woomera and Johannesburg

A commercial toll call will be placed to South Africa prior to each operation. Voice communications to Woomera will use either the Mercury Net on a noninterference basis or a commercial toll call. These circuits will be used as required for the first three operating days after launch and will not be available on a full-time basis. Approximately 10 hours usage is anticipated per day.

c. Mobile Tracking Station

The Mobile Tracking Station will use the same voice circuits as the Johannesburg Station.

d. Cape Canaveral Computing Center

Two voice circuits will be available during the launch period for communications with the launch complex. One circuit will connect the Central Computing Facility with the Cape Canaveral Computing Facility, and the second will be used to coordinate the DSIF and launch activities (Data and Status lines). Note: The Data and Status lines have been renamed RED and GREEN nets.

e. Space Flight Operations Center

Numerous circuits interconnect DSIF Net Control, (Building 125) with the Test Director and other personnel within the Building 125 Space Flight Operations Center and with the Communications Center in Building 190. These circuits include two four-wire hot lines, (Orange and White nets) an intercom system, and a conventional telephone system. Additionally, the DSIF circuits may be paralleled with the colored nets at the discretion of the Test Director.

f. Central Computing Facilities Building 125

Four-wire conference circuits and an intercom system connect the Building 125 computer to the SFOC and the Building 202 computer.

g. Central Computing Facilities Building 202

Four-wire conference circuits and an intercom system connect the Building 202 Computer to the SFOC and the Building 125 Computer.

B. TELETYPE MESSAGE FORMATS

All teletype messages during the mission will use the standard SPACON format:

	(12 LTRS, 5 SP, 2 CR, 2 LF, 2 LTRS)
MM JETLAB	(CR LF LTRS)
DE JOBJET 001	(CR LF LTRS)
M 010203Z	(CR LF LTRS)
BT	(2 CR 2 LF, LTRS OR FIG AS REQUIRED)
(TEXT TEXT	. . . . . .ETC. . . . .)
BT	(2 CR LF LTRS OR FIGS AS REQUIRED)
01/0205Z APR JOBJET	(2 CR, 8 LF)
NNNN (12 LTRS)	

Where:

a. The information in parentheses indicates the characters (i.e., LTRS - letters, SP - space, CR - carriage return, LF - line feed, FIG - figures) which should be "cut" in the message tape before or after a line of page print characters.

b. MM is the message precedence code typed twice. The message precedence codes are:

M - Deferred. Message will be given normal handling and delivered not later than the start of normal working hours at the station of destination.

R - Routine. Message will be routed as soon as it is received. This will normally be the highest classification an administrative message will receive.

P - Priority. Message will be given special and immediate handling. The majority of real time data and important nonreal time data will be given this classification.

O - Operational Immediate. Message will be given instantaneous handling. This classification will normally be reserved for notifying DSIF stations of alarm activation and for transmitting information of special importance (e.g., initial post-injection tracking data).

c. JETLAB and JOBJET give the message destination and originator respectively. For all messages standard SPACON teletype call signs will be used:

Call Sign	Station
JETLAB	Net Control/JPL Communications Center
SPACON	Goddard Space Flight Center
CAPJET	Net Control/JPL Office at Cape Canaveral
JETGLD 2	Goldstone Pioneer Station
JETGLD 3	Goldstone Echo Station
OOMJET	Woomera, DSIF Station
JOBJET	Johannesburg DSIF Station
JETMTS	Mobile Tracking Station
OOMERA	Woomera Minitrack Station
JOBURG	Johannesburg Minitrack Station

d. 001 is the originator's message number.

e. M 010203Z is a repeat of the message precedence code followed by the GMT date-time group. The date-time group indicates respectively, in two-digit increments, the day, hour, and minute of transmission.

f BT is a separative sign dividing the heading from the message text, and also indicates the conclusion of the text.

g. 01 /0205Z APR is the file time of the message and should use a slant sign (/) after the day of the month to avoid confusing the file time group with the date-time group.

h. JOBJET is a repeat of the station originator designation.

If the message text consists of data, an introductory label should be given (e.g., TELEMETRY DATA, TRACKING DATA) and if the time of recording is not given in the data it should be included in the label.

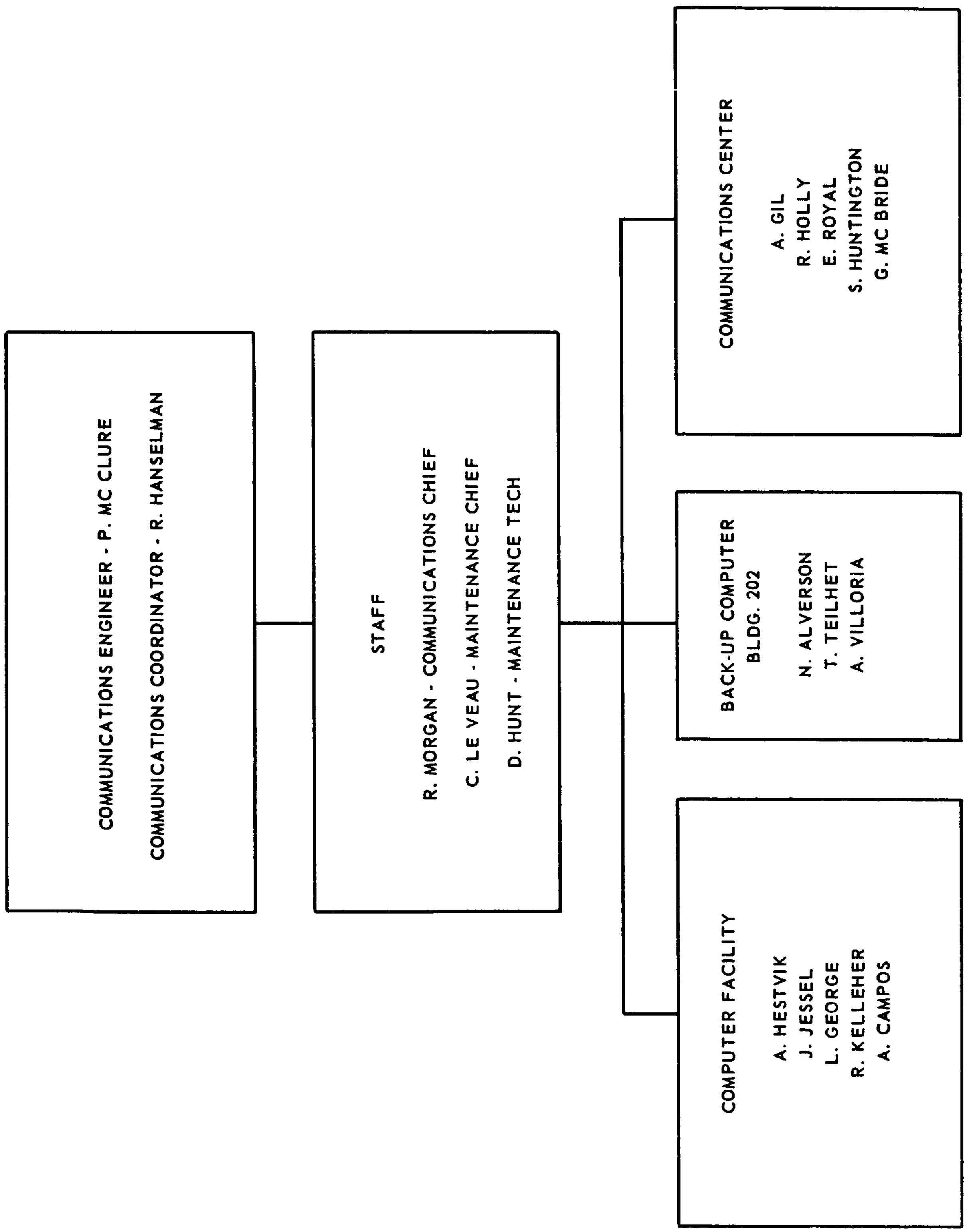


Figure VI-1. Communications Organization

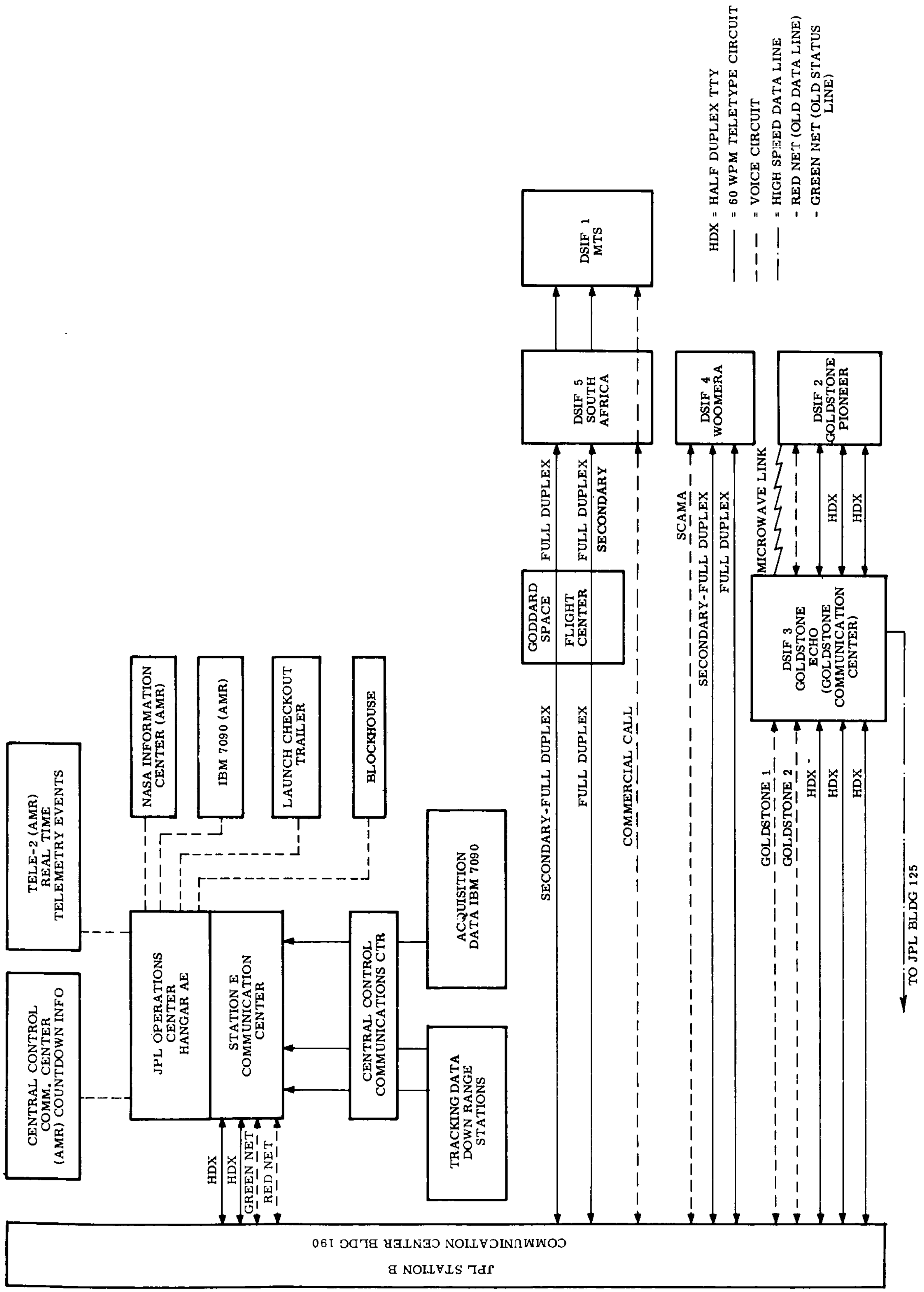


Figure VI-2. Communications Network for Mariner R

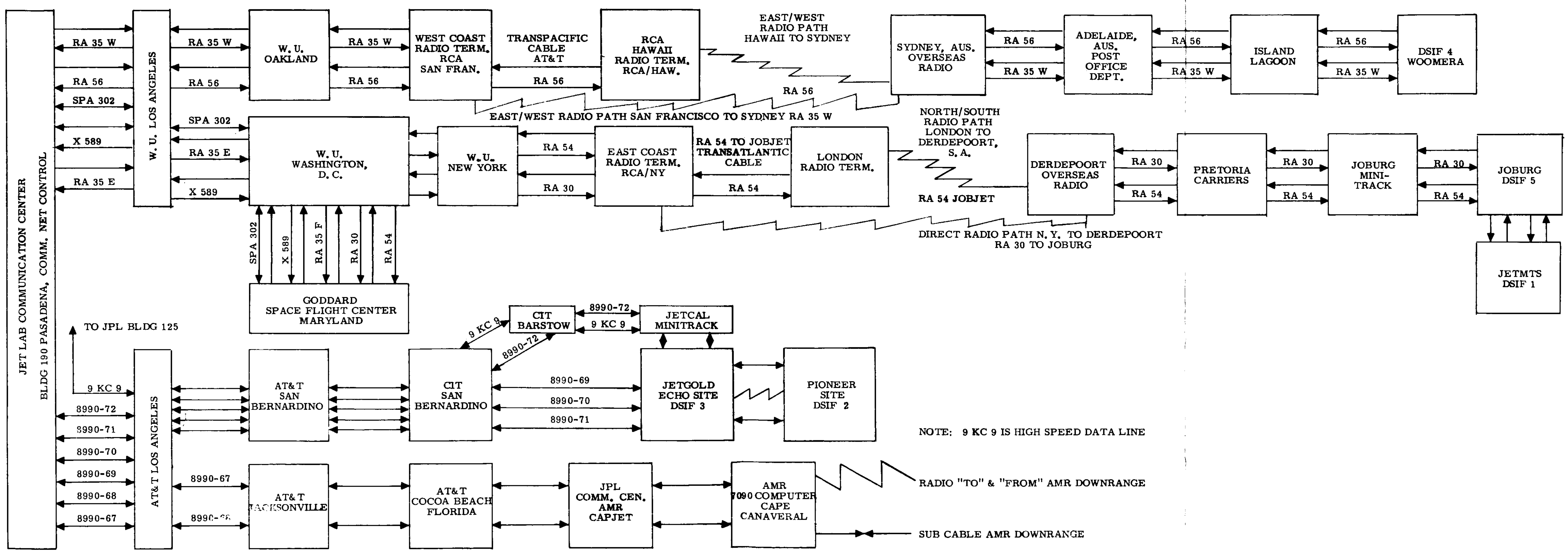


Figure VI-3. Teletype Communication Lines

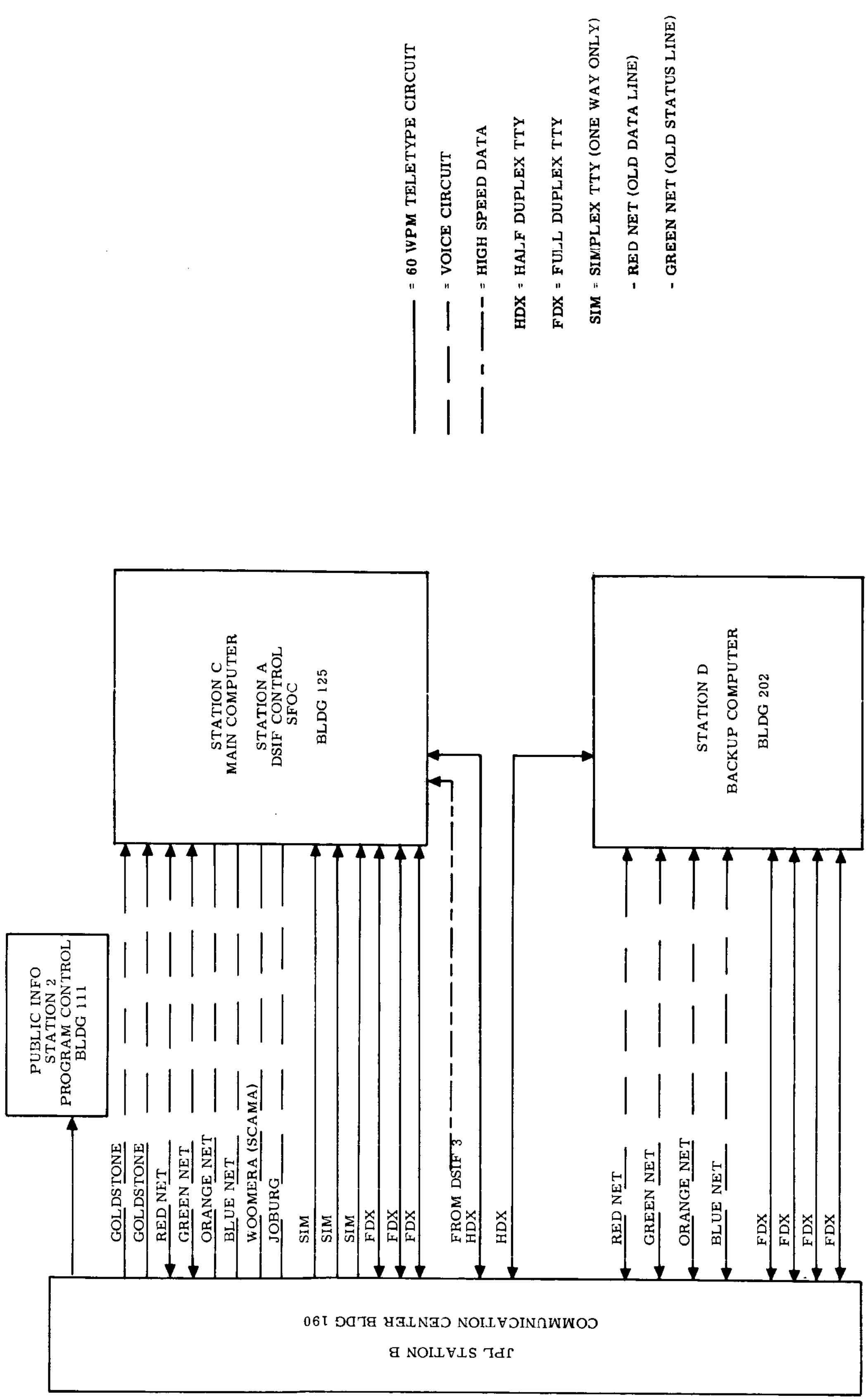


Figure VI-4. Interior Communication Network for Mariner R

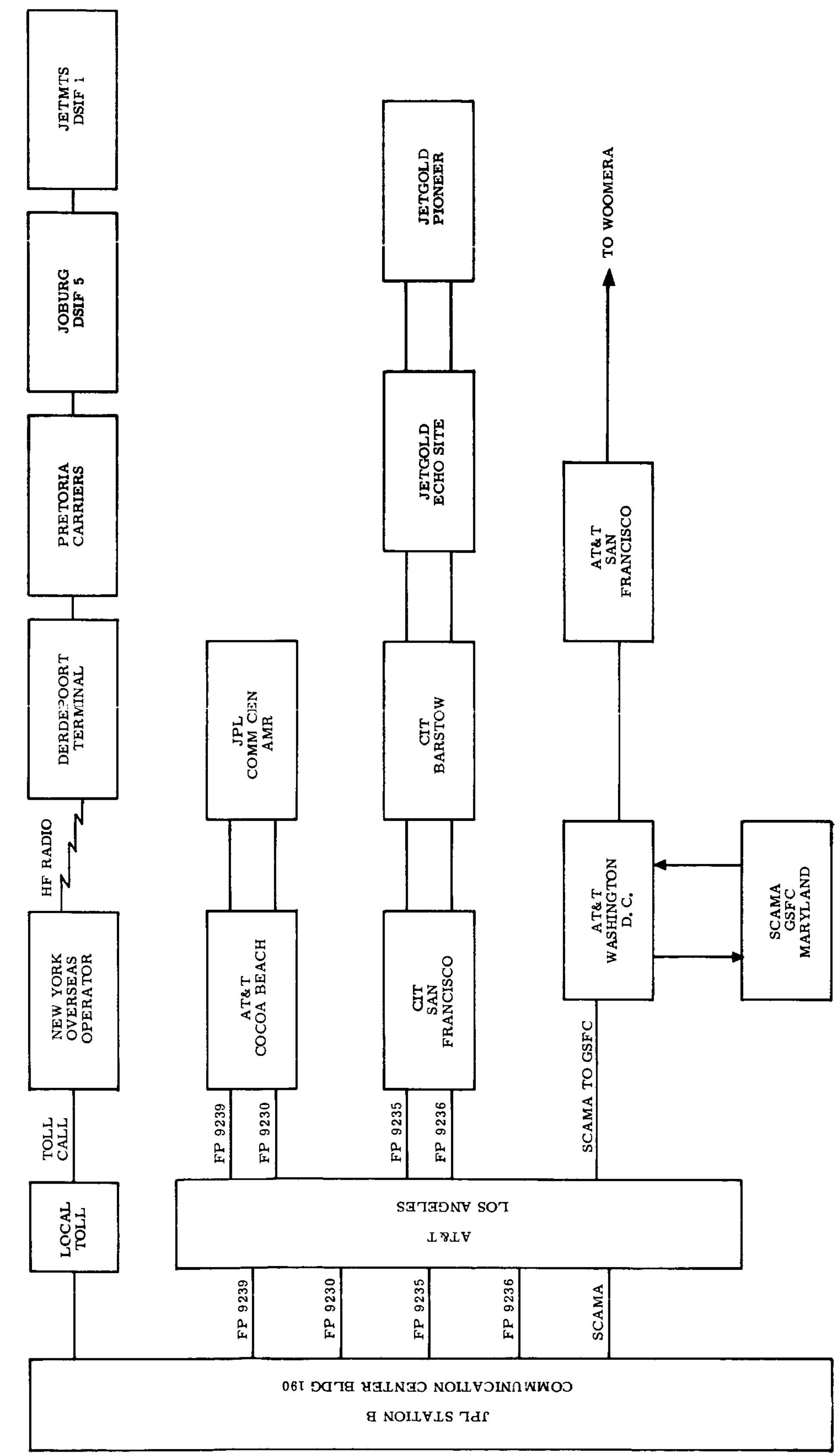


Figure VI-5. Voice Communication Lines

SECTION VII

SCHEDULES

A. PRELAUNCH STATION PREPARATIONS

Prior to the mission a series of tests are required at each station. These tests will consist of star tracks and RF tracking and receiving system evaluations. The results of these tests will be used to define station tracking parameters. The tests to be performed are determined from the results of analysis of data of previous missions and will be provided to the stations via teletype. Test results and data should be sent to JPL (see Section V for address and shipping method).

B. PRELAUNCH OPERATIONAL READINESS TESTS

Two operational readiness tests are scheduled and are identical.

Test	Date	Time*	Duration	Object
1	7-16-62	1000Z	10 hours	Each test will afford a complete system test
2	7-19-62	1000Z	10 hours	

* Time of simulated launch. Table VII-1 specifies the tape and transmission time for each station. The tape recorders should be run at 60 i.p.s. For these tests the standard sequence of events will be used with certain modifications. The modified sequence of events will be transmitted to all stations via TTY on July 10.

C. POSTLAUNCH OPERATIONAL SCHEDULE

The DSIF sequence of events for the launch and postlaunch operations is presented in Table VII-I. This table presents the sequence of events from launch through 8 1/2 days. Based on conditions existing at that time, Net Control will establish an operational schedule through the end of the mission.

Missions prior to this have been lunar missions and the firing period has been for a few days of the month. The TIM's for the lunar missions contained tables that presented variations in acquisition times versus launch azimuth and launch date. Because of the greater launch period (67 days) for the Mariner R missions, it was not possible to generate all this information in advance. When a firm launch date is established, this information will be supplied to the stations by TTY.

The Standard Sequence of Events specifies the expected sequence of events during normal operation of the launch vehicle, the spacecraft, and the spaceflight operations complex. Normal or standard operation assumes all components of the launch vehicle, the spacecraft, and the operations complex function as per design specifications. The capability exists of transmitting eleven real time and three stored commands to the spacecraft. One radio command, RTC-8 CRUISE SCIENCE ON, is listed in the standard sequence of events since only this command is known to be required prior to launch to achieve all the mission objectives. The nominal time listed for the transmission of this command is subject to change as a function of the analysis of the spacecraft telemetry data. The requirements for other ground generated commands will be determined by orbit determination and reduction of telemetry data. (This will be covered in detail in the ANTICIPATED NONSTANDARD SEQUENCE OF EVENTS which will be published as an addendum to the TIM).

Table VII-2 is an arbitrary plot of DSIF view periods for MR-1 and MR-2. The arbitrary parameters chosen for the generation of this table were; 1) launch azimuth of 108°, 2) launch dates early in the launch period. Figs. VII-1 and VII-2 present the variation in launch time versus launch date.

TABLE VII-1. OPERATIONAL READINESS TEST TRANSMISSION PERIODS

DSIF STATION	REEL NUMBER	TAPE START TIME	END OF REEL
5	1	L + 57.5 m	L + 69.5 m
5	2	L + 75 m	L + 89 m
3 and 4	3	L + 166 h 43 m	L + 167 h 05 m
3	4	M* -5 m	M + 7 m
3	5	M + 8 m	M + 24 m
3	5 repeat	M + 68 m	M + 84 m
3	5 repeat	M + 88 m	M + 104 m
3	6	M + 105 m	M + 121.5 m
3	6 repeat	M + 180 m	M + 196.5 m

* M = time RTC-6 is transmitted to start M/C maneuver.

Table VII-2. Typical DSIF View Periods for MR-1 and MR-2

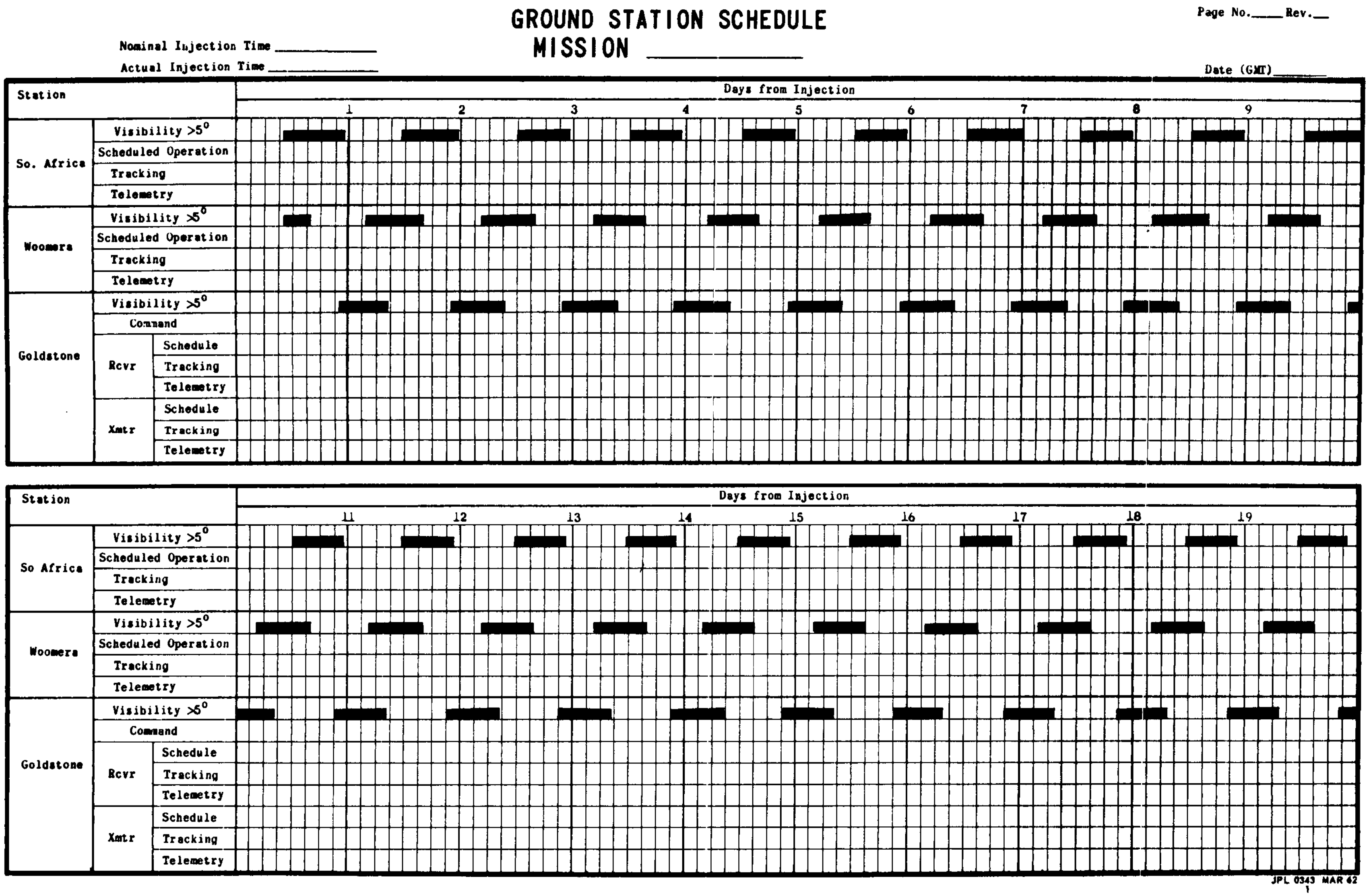


Table VII-2. (Cont'd)

GROUND STATION SCHEDULE

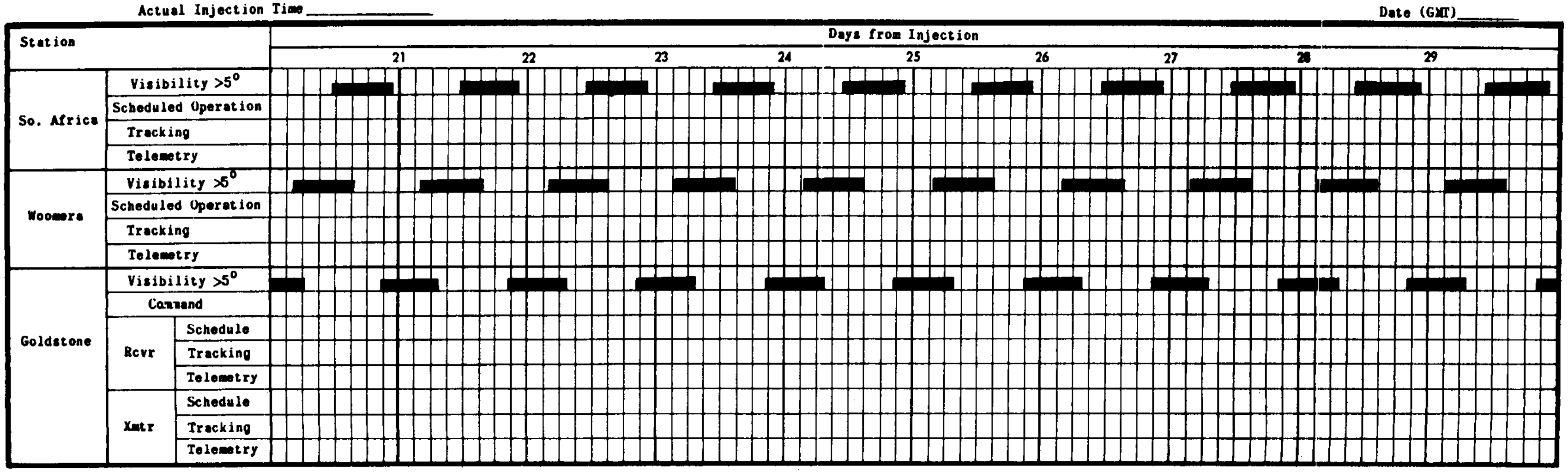
MISSION ______________

Nominal Injection Time ____________

Actual Injection Time ____________

Page No.____ Rev.___

Date (GMT)______



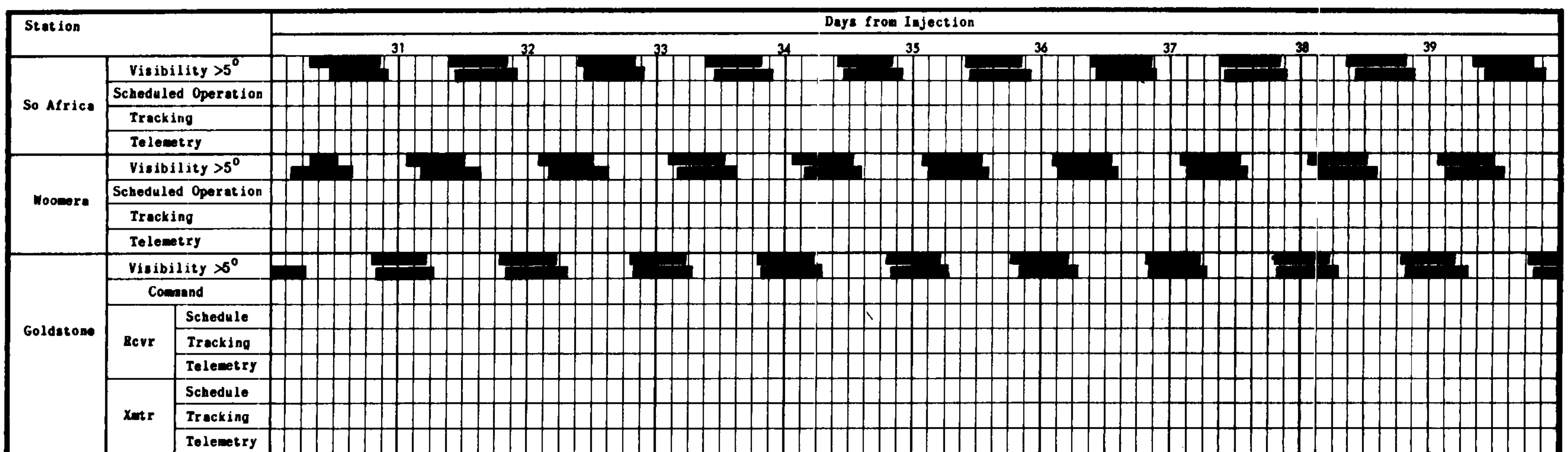


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Table VII-2. (Cont'd)

GROUND STATION SCHEDULE
MISSION ______

Nominal Injection Time ______
Actual Injection Time ______

Page No. ______ Rev. ______

Date (GMT) ______

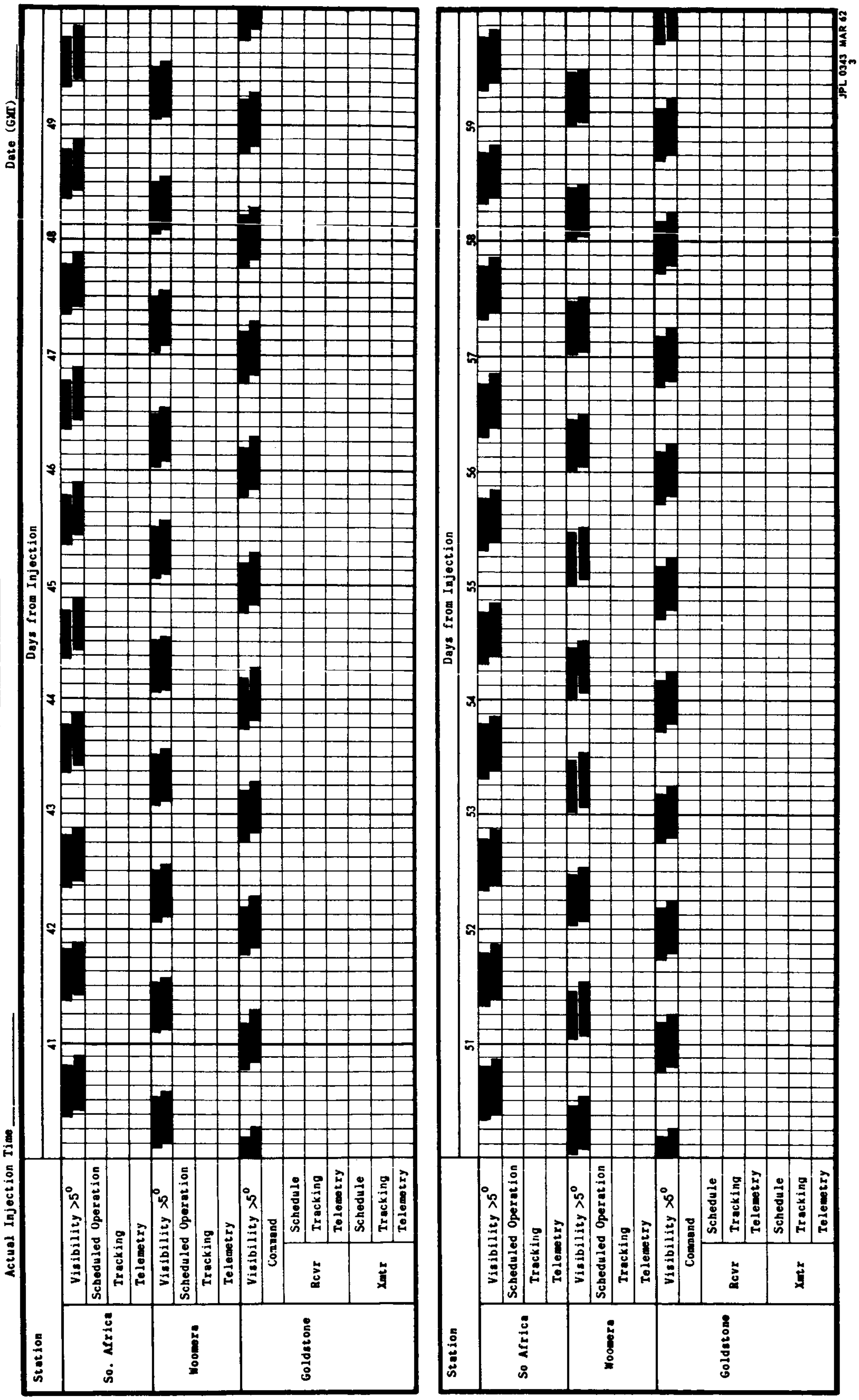

Table VII-2. (Cont'd)

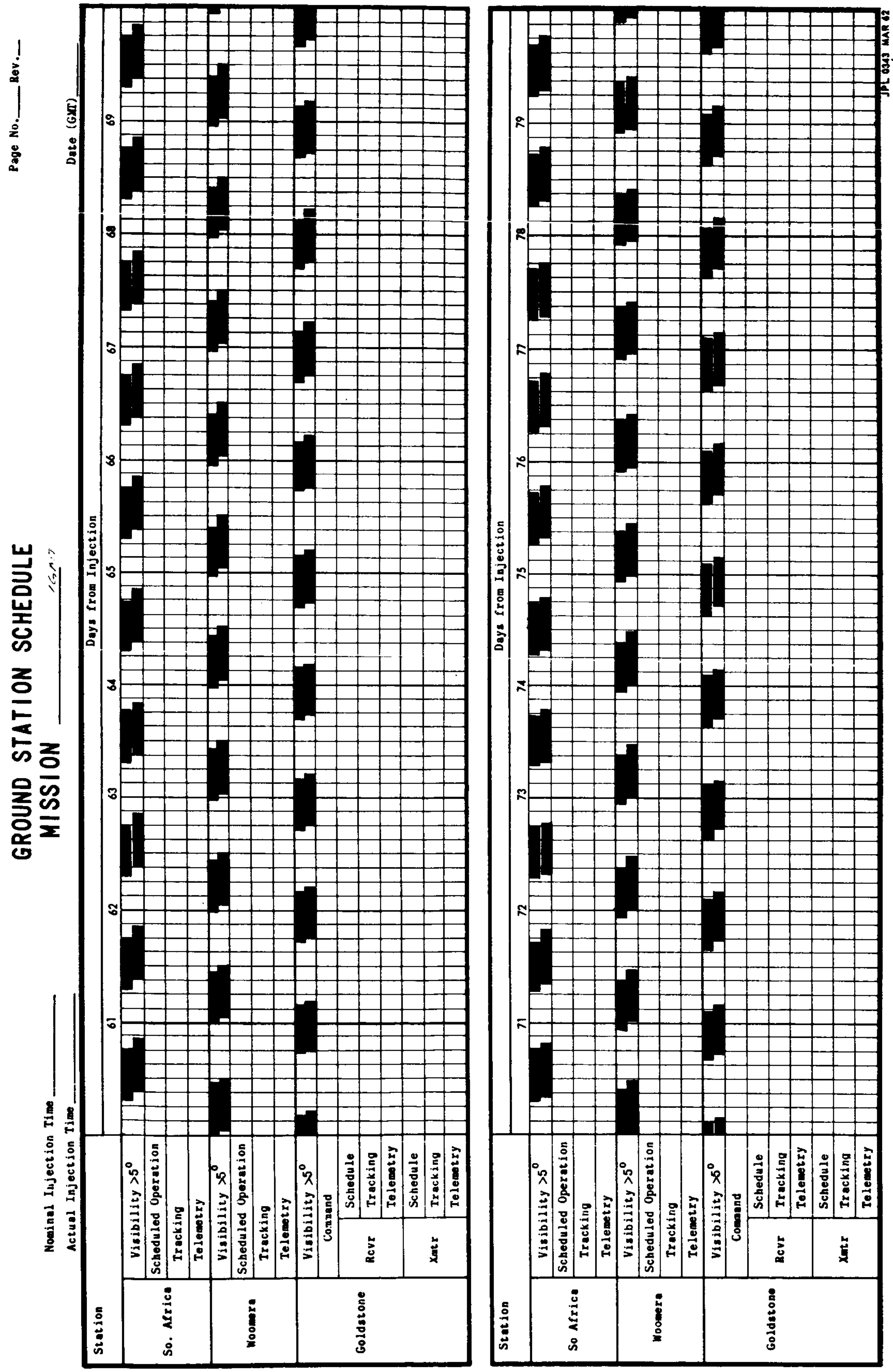

Table VII-2. (Cont'd)

Page No.____ Rev.__

GROUND STATION SCHEDULE

Nominal Injection Time ____________

Actual Injection Time ____________

MISSION ____________

Date (GMT) ______

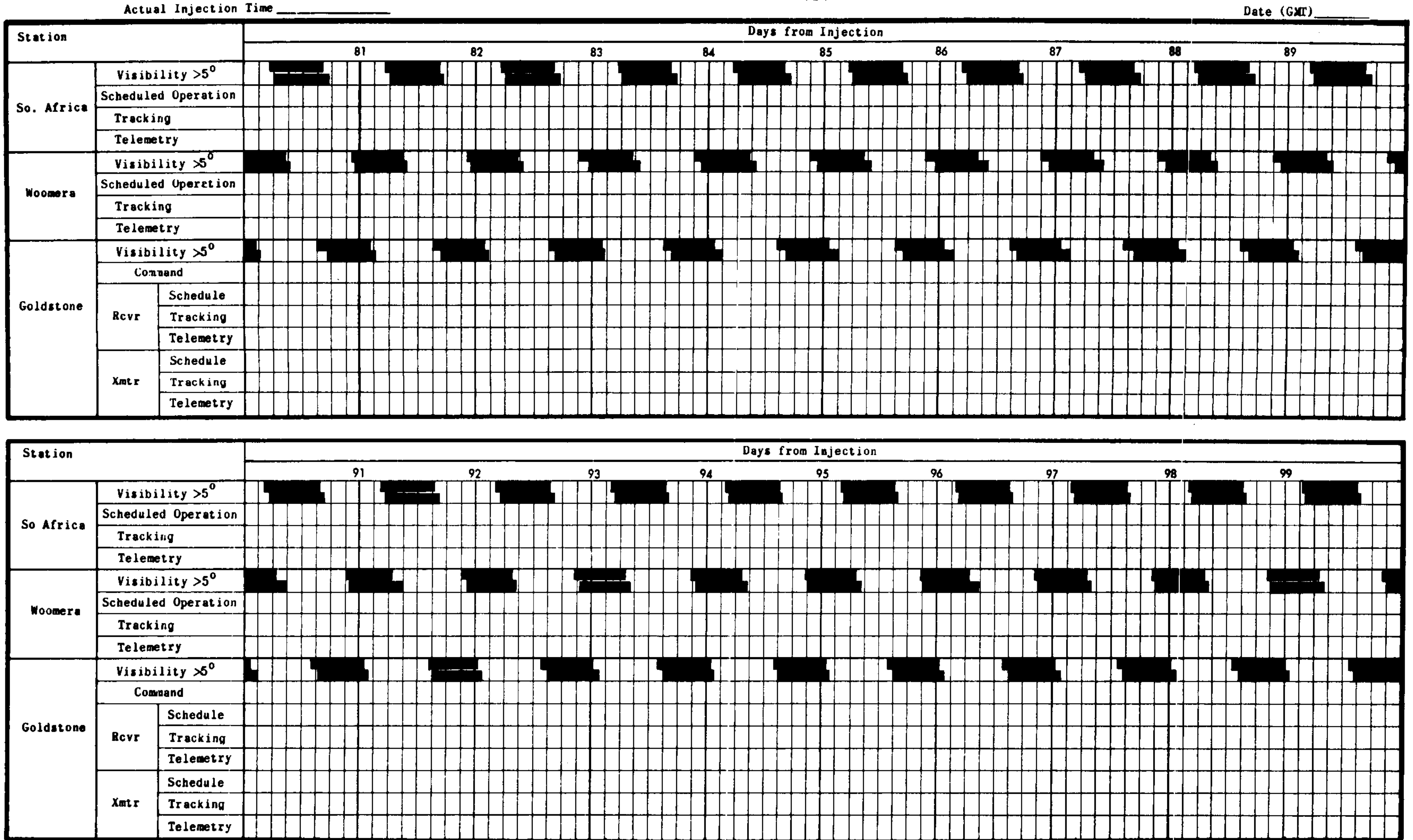

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Table VII-2. (Cont'd)

GROUND STATION SCHEDULE

MISSION

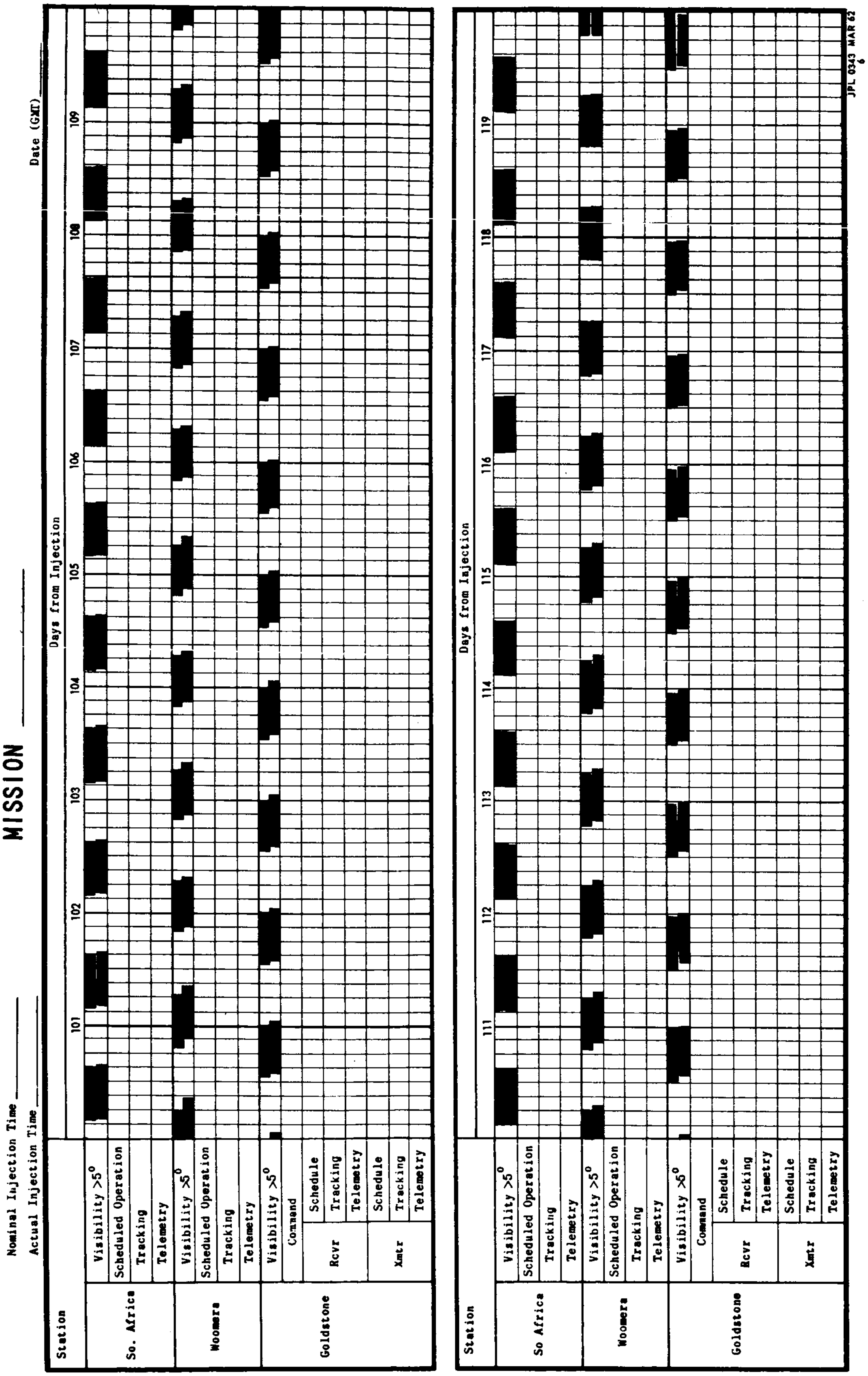


Table VII-2. (Cont'd)

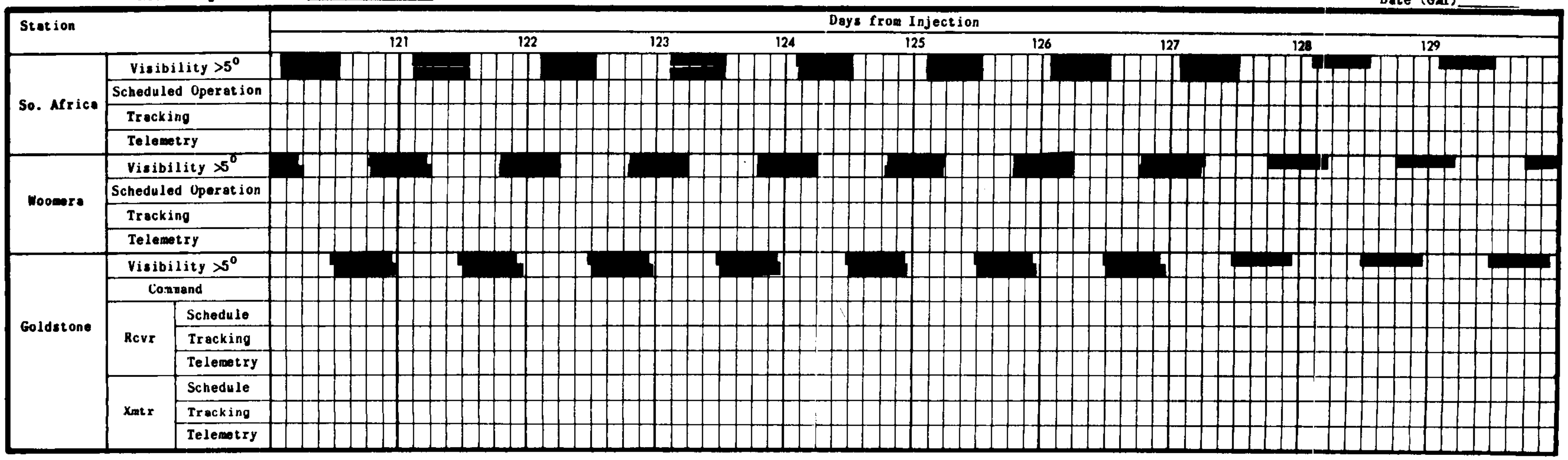
Page No.____ Rev.___

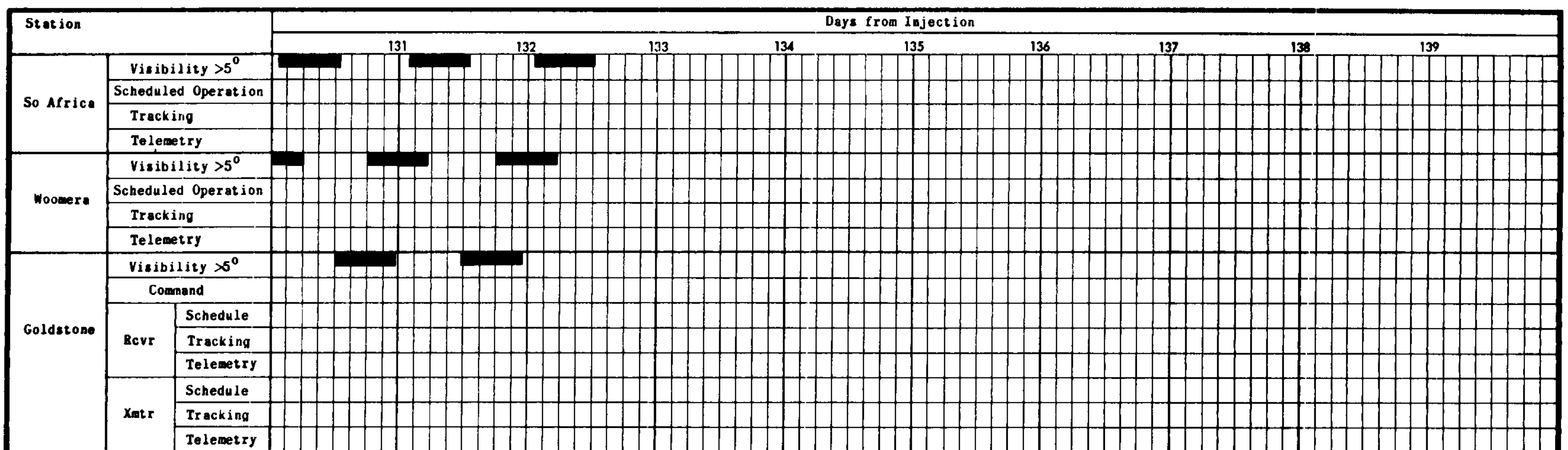
GROUND STATION SCHEDULE
MISSION ____________

Nominal Injection Time ____________

Actual Injection Time ____________

Date (GMT)________





JPL 0343 MAR 62
7

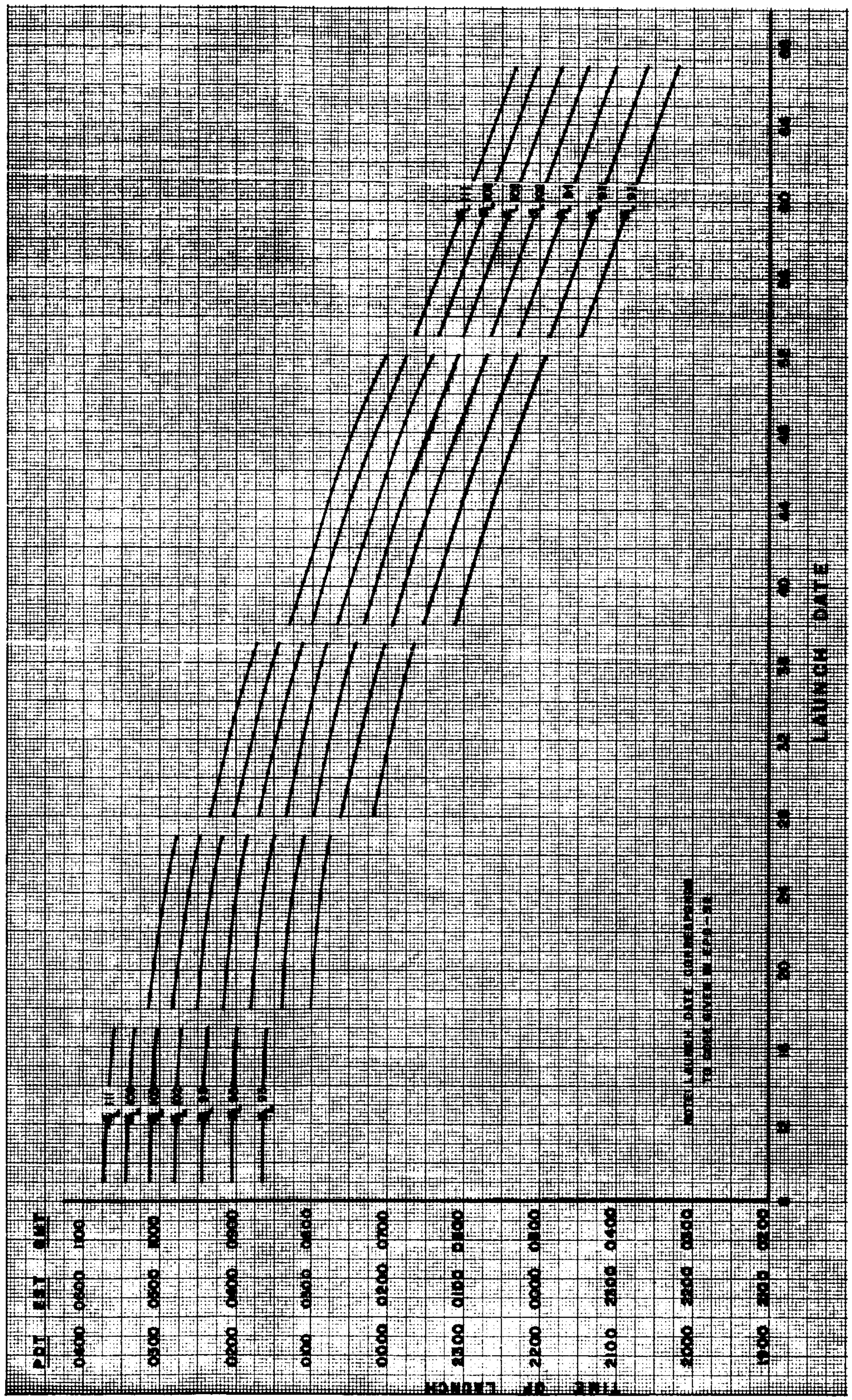


Figure VII-1. Variation in Time of Launch as a Function of Launch Azimuth and Launch Date

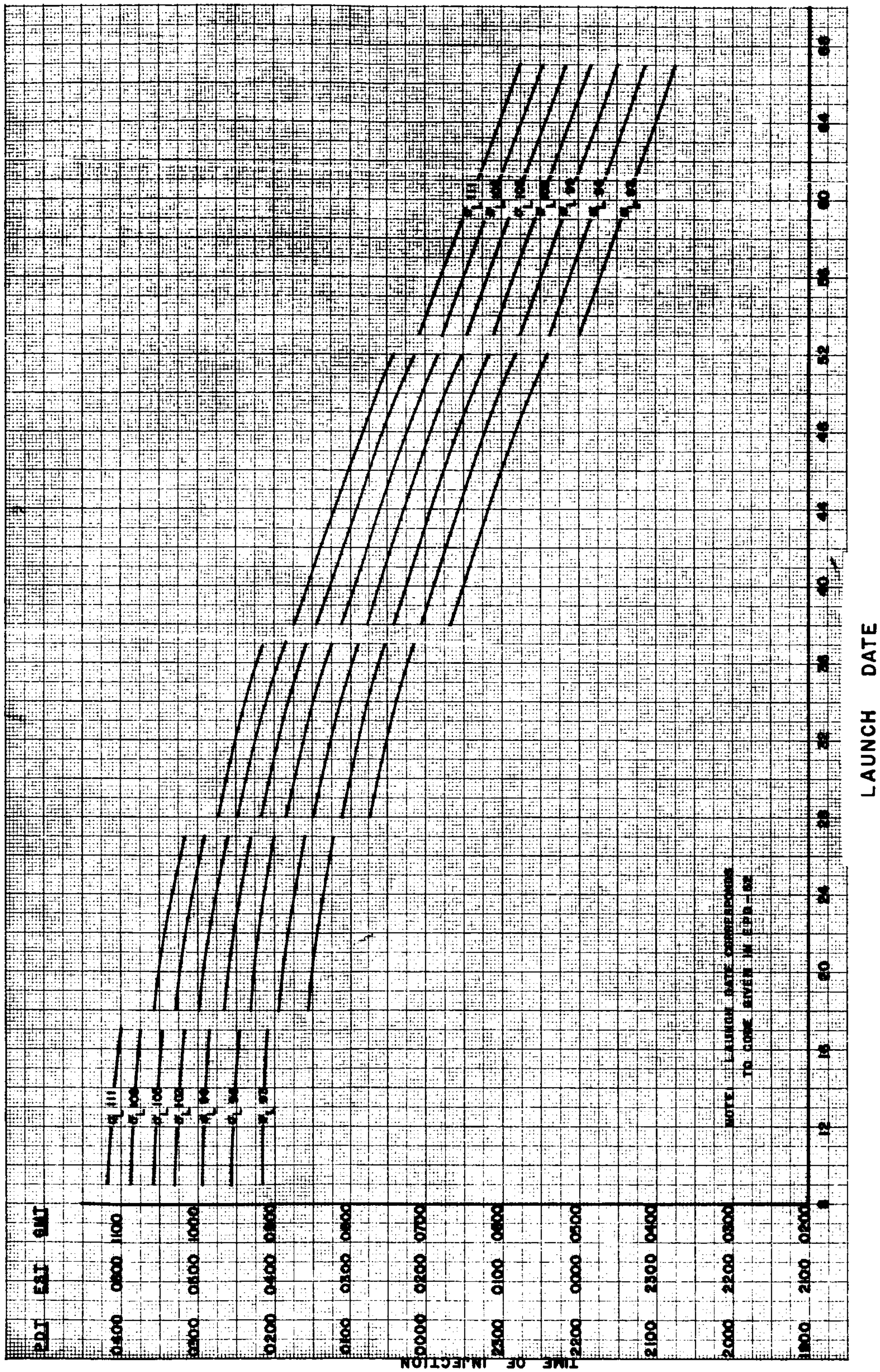


Figure VII-2. Variation in Time of Injection as a Function of Launch Azimuth and Launch Date

Note. The launch day number is referenced to a code in EPD-52, which is classified. This information will be supplied to the stations, by TTY, as soon as it is unclassified. These figures and tables are presented for the purpose of illustrating a typical set of view periods involving both spacecraft and must not be construed as representing firm, planned, launch dates, launch azimuths, or launch date separation for the two spacecraft. At the time the second spacecraft is launched, the upper bar is used to represent the view periods of MR-2 and the lower bar to represent the view periods of MR-1.

The Standard Sequence of Events specifies the expected events during nominal operation of the spacecraft and the space flight operations complex. The complexity of the mission and the inherent difficulties associated with its execution require a clear understanding of and the differentiation between standard and nonstandard operation. The necessary and sufficient conditions for standard operation to have been achieved are:

1) That all components of the spacecraft and the operations complex function as designed.
2) That the attitude control system acquires the Sun and Earth.
3) That upon radio command (RTC-4), communication is established between Earth and spacecraft via the high gain antenna.
4) That, if required, a successful midcourse maneuver is performed. While the standard trajectories for the mission are not predicated on a midcourse maneuver, it is highly probable that a midcourse maneuver will be performed.
5) That science telemetry is switched on and functioning properly.

A departure from the standard operation does not, in itself, imply a mission failure. The nature of the mission is such that the number of nonstandard modes of operation is relatively high. A departure from the standard mode of operation achieves most significance if the capability exists to optimize the nonstandard situation. In the resulting optimization process, careful consideration must be given to the alternate courses of action, their relative priority and the current operational state of the spacecraft and the space flight operations complex. Should a situation occur, or exist, which is nonstandard, the Space Flight Test Director with the advice of the cognizant group representatives will determine the course of action to be followed which in turn is subject to the approval of the Project Manager.

Table VII-3 presents the sequence of events correlating the events, times of occurrence, and stations involved. All events appearing opposite and under one block of time are identified by an "item" letter or number. The items occurring before liftoff are lettered; all items beginning with liftoff and continuing through the conclusion of the table are numbered in sequence, with liftoff identified as Item No. 1.

The abbreviations used in the table are listed below under the columnar heading in which they appear.

Time of Event Column Standard

T = Countdown time before liftoff

L = Time of liftoff

I = Time of injection

Station Column

A	=	Space Flight Operations Center (SFOC)
IPP	=	Computing Facility at AMR
C	=	Central Computing Facility, Bldg. 125 (CCF)
E	=	JPL Cape Canaveral Operations Center, Hangar AE, CAPJET
S/C	=	Spacecraft
1.16	=	Cape Canaveral (FPS-16)
91	=	Antigua
12	=	Ascension Island
TFV	=	Twin Falls Victory Ship, Atlantic Ocean
13	=	Pretoria, South Africa
0	=	DSIF-0 = LCTT = Launch Checkout Telemetry Trailer, Cape Canaveral
1	=	DSIF-1, Mobile Tracking Station, South Africa, JETMTS

2	=	DSIF Station 2, Goldstone Pioneer Station, California, JETGLD 2
3	=	DSIF Station 3, Goldstone Echo Station, California, JETGLD 3
4	=	DSIF Station 4, Woomera, Australia, OOMJET
5	=	DSIF Station 5, Johannesburg, South Africa, JOBJET
*	=	Designated events which will be communicated by voice
Z	=	Program Control, Bldg. 111

TABLE VII-3. STANDARD SEQUENCE OF EVENTS

ITEM	TIME OF EVENT STANDARD	TIME OF EVENT ACTUAL	STATION	EVENT
G	T-300M		B	1. ESTABLISH COMMUNICATIONS BETWEEN A,B, C, AND IPP.
				2. TRANSMIT OPERATIONAL READINESS REPORT TO A.
			*E	1. TRANSMIT VALUES OF ANTENNA HINGE REFERENCE ANGLE AND ENCOUNTER PARAMETERS TO A.
F	T-115M		IPP,C, D	1. START CHECKOUT OF COMPUTER AND DATA HANDLING EQUIPMENT.
E	T-90M		*E	1. TRANSMIT S/C FREQUENCIES AND TEMPERATURE TO A.
				A) TRANSPONDER CARRIER FREQUENCY ON AUXILIARY OSCILLATOR DRIVE.
				B) GROUND TRANSMITTER 890 MC FREQUENCY AT ZERO SPE VOLTS
				C) TRANSPONDER 960 MC FREQUENCY AT ZERO SPE VOLTS.
				D) CASE II TEMPERATURE
		---------- 60 MINUTE HOLD ----------		
D	T-60M		*A	1. TRANSMIT OPERATIONAL READINESS REPORT TO E.
			*E	1. TRANSMIT S/C STATUS REPORT TO A.
C	T-40M		E	1. TRANSMIT S/C FREQUENCIES AND TEMPERATURE TO A.
				A) TRANSPONDER CARRIER FREQUENCY ON AUXILIARY OSCILLATOR DRIVE
				B) GROUND TRANSMITTER 890 MC FREQUENCY AT ZERO SPE VOLTS

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
C	(CONTINUED)			C) TRANSPONDER 960MC FREQUENCY AT ZERO SPE VOLTS
				D) GROUND TRANSMITTER 890 MC FREQUENCY CORRESPONDING TO AVERAGE NO SIGNAL TRANSPONDER SPE VOLTAGE.
				E) TRANSPONDER AVERAGE NO SIGNAL SPE VOLTAGE
				F) CASE II TEMPERATURE
				2. SET ANTENNA HINGE REFERENCE ANGLE. REPORT TO A.
				3. REPORT LATEST TIME OF D O SYNC TO A.
B	T-12M		*E	1. INSERT ENCOUNTER PARAMETER INTO CC AND S. REPORT TO A.
	--------- UP TO 15 MINUTE HOLD AT T-5M ---------			
A	T-5M		E	1. TRANSMIT S/C STATUS REPORT TO A.
			*A	1. TRANSMIT OPERATIONAL READINESS REPORT TO E.
1	L=T		*E	1. LIFTOFF. REPORT TO A.
			IPP	1. START REAL TIME RANGE SAFETY IMPACT PREDICTION.
			C	1. START COMPUTATION OF STANDARD TRAJECTORY AND NOMINAL PREDICTIONS FOR DSIF 1,4, AND 5.
2	L+10S		1.16	1. ACQUISITION BY 1.16 AND DSIF 0.
3	L+	=MARK1	*E	1. REPORT BOOSTER CUTOFF TO A.

ITEM	TIME OF EVENT STANDARD ACTUAL	STATION	EVENT
4	L+ =MARK2	*E	1. BOOSTER JETTISON
5	L+ =MARK3	*E	1. REPORT SUSTAINER CUTOFF TO A.
6	L+ =MARK4	*E	1. REPORT VERNIER CUTOFF TO A.
7	L+295S=MARK5	VEH	1. SHROUD EJECTION.
8	L+300S=MARK6	*E	1. REPORT ATLAS AGENA SEPARATION.
9	L+325S	*IPP	1. COMPLETE REAL TIME RANGE SAFETY IM- PACT PREDICTION.
			2. START COMPUTATION AND DISPLAY OF POSITION OF VEHICLE, RECORD DATA FOR COMPUTING TFV SHIP ACQUISITION INFORMATION AND ORBITAL ELEMENTS.
10	L+330S	*91	1. S/C ON 91 HORIZON, START TRANSMISSION OF TRACKING DATA TO IPP AND C.
11	L+349S=MARK7	*E	1. REPORT 1ST AGENA IGNITION.
12	L+360S	C	1. TRANSMIT STATION ACQUISITION PREDICTION INFORMATION TO DSIF 1,4, AND 5.
13	L+438S	1.16	1. LOSS OF TRACK BY 1.16 AND DSIF 0.
14	L+500S=MARK8	*E	1. 1ST AGENA BURNOUT. E REPORT TO A AS SOON AS POSSIBLE.
18	L+715S	*IPP	1. COMPLETE COMPUTATION OF ORBITAL ELEMENTS OF

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
18	(CONTINUED)			PARKING ORBIT. START TRANSMISSION TO C.
				2. START COMPUTATION OF S/C INJECTION CONDITIONS AND ACQUISITION INFORMATION FOR DSIF 1, 4, 5.
				3. COMPLETE TRANSMISSION OF ORBITAL ELEMENTS TO A.
19	L+750S		91	1. LOSS OF TRACK BY 91.
20	L+827S		*IPP	1. COMPLETE COMPUTATION OF INJECTION CONDITIONS AND ACQUISITION INFORMATION AND START TRANSMISSION OF DSIF 1, 4, 5 ACQUISITION INFORMATION TO A AND C FOR RELAY TO 1,4,5.
21	L+1013S		*IPP	1. COMPLETE TRANSMISSION OF DSIF 1,4,5 ACQUISITION INFORMATION TO A AND C.
22	L+1170S		12	1. S/C ON 12 HORIZON. START TRANSMISSION OF TRACKING DATA TO IPP AND C.
23	L+1334S=MARK9		12	1. 2ND AGENA IGNITION. E REPORT TO A.
24	L+1450S		TFV	1. S/C ON TFV HORIZON. START TRANSMISSION OF TRACKING DATA TO IPP AND C.
25	L+1500S		12	1. LOSS OF TRACK BY 12.
26	I=L+1619S=MARK10		TFV	1. 2ND AGENA CUTOFF. E REPORT TO A.
27	I+100S		IPP	1. START COMPUTATION OF S/C

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
27	(CONTINUED)			INJECTION CONDITIONS FROM 12 AND TFV DATA.
28	I+135S		1,5	1. S/C ON DSIF 1 AND 5 HORIZON
			13	1. S/C ON 13 HORIZON
29	I+140S		IPP	1. COMPLETE COMPUTATION OF S/C INJECTION CONDITIONS AND TRANSMIT TO A.
				2. START COMPUTATION OF DSIF 1,4, AND 5 AQUISITION INFORMATION.
30	I+156S=MARK11		S/C	1. S/C AGENA SEPARATION
				A. TRANSMITTER POWER UP.
				B. ARM PYROTECHNICS
				C. ENABLE CC AND S.
31	I+4M		IPP	1. START TRANSMISSION OF ACQUISITION INFORMATION FOR RELAY TO DSIF 1,4, AND 5 BY A AND C.
32	I+5M		1	1. REPORT ONE-WAY LOCK TO A. START TRANSMITTING TRACK-ING DATA TO C.
			5	1. REPORT ACQUISITION TO A. START TRANSMITTING TRACK-ING DATA TO C.
33	I+10M		1	1. ACQUIRE S/C IN TWO-WAY LOCK
34	I+12M		5	1. STOP TRANSMISSION OF TRACKING DATA TO C. STORE TRACKING DATA.
				2. START PUNCHING AND TRANS-MITTING TELEMETRY TO C.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
35	I+17M=L+44M		S/C	1. UNFOLD SOLAR PANELS.
				2. UNLATCH RADIOMETER.
36	I+19M		4	1. S/C ON DSIF 4 HORIZON.
37	I+20M		1,4,5	1. TRANSMIT STATION REPORT TO A.
38	I+24M		4	1. REPORT ACQUISITION TO A. START TRANSMISSION OF TRACKING DATA TO C.
39	I+25M		C	1. START COMPUTATION OF PRELIMINARY ORBIT USING TRACKING DATA FROM 1 AND 5 AND INJECTION CONDITIONS FROM IPP.
40	I+28M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
				2. START NEW TRANSMISSION OF CURRENT TELEMETRY DATA TO C.
42	I+33M=L+60M		S/C	1. TURN ON ATTITUDE CONTROL
				A) EXTENDS ANTENNA
				B) ACTIVATES SUN SENSOR SYSTEM.
				C) ACTIVATES GAS JET SYSTEM.
				D) COMMENCES AUTOMATIC SUN ACQUISITION.
43	I+35M		C	1. COMPLETE COMPUTATION OF PRELIMINARY ORBIT.
				2. REVISE PREDICTION INFORMATION FOR DSIF 1,4, AND 5.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
43	(CONTINUED)		1	1. STOP TRANSMISSION OF TRACKING DATA TO C. STORE TRACKING DATA.
			5	1. START TRANSMISSION OF STORED TRACKING DATA TO C.
44	I+36M		4	1. TRANSMIT TELEMETRY DATA TO C.
45	I+40M		1,4,5	1. TRANSMIT STATION REPORT TO A.
46	I+60M		1,4,5	1. TRANSMIT STATION REPORT TO A.
			C	1. TRANSMIT PREDICTION INFORMATION TO DSIF 1,4,AND 5.
47	I+63M=L+90M		S/C	1. LATEST TIME OF COMPLETION OF SUN ACQUISITION. GYROS TURNED OFF.
49	I+80M		1,4;5	1. TRANSMIT STATION REPORT TO A.
51	I+98M		5	1. STOP TRANSMISSION OF TELEMETRY DATA TO C.
52	I+100M		1,4,5	1. TRANSMIT STATION REPORT TO A.
54	I+120M		1,4,5	1. TRANSMIT STATION REPORT TO A.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
			C	1. COMPLETE COMPUTATION OF FIRST ORBIT.
				2. REVISE AND TRANSMIT PREDICTION INFORMATION FOR DSIF 1,4, AND 5.
55	I+140M		1,4,5	1. TRANSMIT STATION REPORT TO A.

ITEM	TIME OF EVENT STANDARD	TIME OF EVENT ACTUAL	STATION	EVENT
57	I+160M		1,4,5	1. TRANSMIT STATION REPORT TO A.
59	I+176M		5	1. STOP TRANSMISSION OF TELEMETRY DATA TO C.
61	I+180M		1,4,5	1. TRANSMIT STATION REPORT TO A.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
62	I+200M		1,4,5	1. TRANSMIT STATION REPORT TO A.
63	I+220M		1,4,5	1. TRANSMIT STATION REPORT TO A.
64	I+236M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
65	I+239M		1,4,5	1. TRANSMIT STATION REPORT TO A.
66	I+240M		1,4,5	1. TRANSMIT STATION REPORT TO A.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
			C	1. COMPLETE COMPUTATION OF 2ND ORBIT.
				2. COMPUTE AND TRANSMIT PREDICTION INFORMATION FOR DSIF 1,2,3,4,AND 5.
67	I+260M		1,4,5	1. TRANSMIT STATION REPORT TO A.
69	I+280M		1,4,5	1. TRANSMIT STATION REPORT TO A.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
70	I+296M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
72	I+300M		1,4,5	1. TRANSMIT STATION REPORT TO A.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
73	I+320M		1,2,3, 4,5	1. DSIF STATIONS WILL TRANSMIT STATION REPORTS THROUGHOUT THE MISSION AS INDICATED IN TABLE . NO FURTHER STATION REPORT TIMES WILL BE IN THIS SEQUENCE.
74	I+356M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
76	I+360M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
77	I+368M		4	1. LOSS OF TRACK BY DSIF 4.
				2. CONTINUE TRANSMISSION OF TELEMETRY DATA UNTIL COMPLETED.
79	I+416M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
			1	1. START TRANSMITTING TRACKING DATA TO C.
83	I+480M		1	1. STOP TRANSMISSION OF TRACKING DATA TO C.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
84	I+536M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.

ITEM	TIME OF EVENT STANDARD	TIME OF EVENT ACTUAL	STATION	EVENT
84	(CONTINUED)		1	1. START TRANSMITTING TRACKING DATA TO C.
88	I+600M		1	1. STOP TRANSMISSION OF TRACKING DATA.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
89	I+656M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
			1	1. START TRANSMITTING TRACK-ING DATA TO C.
92	I+720M		1	1. STOP TRANSMISSION OF TRACKING DATA.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
93	I+748M		2,3	1. REPORT AQUISITION OF THE S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
				3. START TRANSMISSION OF TELE-METRY DATA.
94	I+776M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
			1	1. START TRANSMITTING TRACKING DATA TO C.
97	I+820M		1,5	1. LOSS OF TRACK BY DSIF 1 AND 5.
				2. CONTINUE TRANSMISSION OF TRACK-ING DATA FROM 1 AND 5 UNTIL COMPLETED.
98	I+1136M		4	1. REPORT ACQUISITION OF S/C TO A.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
98	(CONTINUED)			2. START TRANSMISSION OF TRACKING DATA TO C.
100	I+1320M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
101	I+1371M		2,3	1. LOSS OF TRACK BY DSIF 2 AND 3.
102	I+1400M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
103	I+1520M		C	1. COMPLETE COMPUTATION OF 3RD ORBIT.
				2. COMPUTE AND TRANSMIT PREDICTION INFORMATION FOR DSIF 1,2,3,4,AND 5.
106	I+1577M		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
107	I+1610M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
108	I+1690M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
110	I+1695M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
112	I+1775M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
115	I+1820M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
116	I+1833M		4	1. LOSS OF TRACK BY DSIF 4.
117	I+1900M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
120	I+2020M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
121	I+2100M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
124	I+2186M		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
125	I+2220M		3	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
126	I+2269M		5	1. LOSS OF TRACK BY DSIF 5
127	I+2579M		4	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
128	I+2818M		3	1. LOSS OF TRACK BY DSIF 3.
129	I+2820M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
130	I+2900M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
133	I+3017M		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
134	I+3050M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
135	I+3130M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
138	I+3150M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
139	I+3230M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
142	I+3274M		4	1. LOSS OF TRACK BY DSIF 4.
143	I+3280M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
144	I+3360M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
147	I+3470M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
148	I+3550M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
151	I+3623M		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
152	I+3650M		3	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
153	I+3709M		5	1. LOSS OF TRACK BY DSIF 5.
154	I+4018M		4	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
155	I+4258M		3	1. LOSS OF TRACK BY DSIF 3.
156	I+4350M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
157	I+4430M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
160	I+4455M		5	1. REPORT ACQUISITION OF S/C TO A.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
160	(CONTINUED)			2. START TRANSMITTING TRACKING DATA TO C.
161	I+4490M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
162	I+4570M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
165	I+4611M		4	1. LOSS OF TRACK BY DSIF 4.
166	I+5059M		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
				3. START TRANSMITTING TELEMETRY DATA TO C.
167	I+5146M		5	1. LOSS OF TRACK BY DSIF 5.
170	I+5455M		4	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
171	I+5696M		3	1. LOSS OF TRACK BY DSIF 3.
173	I+5790M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
174	I+5870M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
176	I+5892M		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
177	I+5920M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
178	I+6100M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
180	I+6148M		4	1. LOSS OF TRACK BY DSIF 4.
181	I+6220M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
182	I+6300M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
184	I+6495M		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
				3. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
185	I+6583M		5	1. LOSS OF TRACK BY DSIF 5.
188	I+6892M		4	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
189	I+7134M		3	1. LOSS OF TRACK BY DSIF 3.
191	I+7220M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
192	I+7300M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
194	I+7329M		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
195	I+7360M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
196	I+7440M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
198	I+7585M		4	1. LOSS OF TRACK BY DSIF 4.
199	I+7660M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
200	I+7740M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
202	I+7931M		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
				3. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
203	I+8020M		5	1. LOSS OF TRACK BY DSIF 5.
206	I+8329M		4	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
207	I+8571M		3	1. LOSS OF TRACK BY DSIF 3.
209	I+8660M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
210	I+8740M		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
212	I+8766M		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
213	I+8800M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
214	I+8880M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
216	I+9022M		4	1. LOSS OF TRACK BY DSIF 4.
217	I+9100M		5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
218	I+9180M		5	1. STOP TRANSMISSION OF TELEMETRY DATA.
220	I+9369M		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACK-ING DATA TO C.
				3. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
221	I+9457M		5	1. LOSS OF TRACK BY DSIF 5.
224	I+9765M		4	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
225	I+9980M		4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
226	I+9995M=L+167H		S/C	1. REMOVE INHIBIT ON AUTO-MATIC EARTH ACQUISITION.
				A) START ROLL SEARCH.
				B) TURN ON GYROS.
				C) DECREASE DATA RATE TO 8.3 BPS.
227	I+10008M		3	1. LOSS OF TRACK BY DSIF 3.
229	I+10025M=L+167.5H		S/C	1. EARTH ACQUISITION COMPLETE,

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
229	(CONTINUED)			A) ROLL SEARCH STOPS.
				B) HINGE SERVO STARTS.
				C) GYROS STOP.
				D) SWITCH 960MC TRANSMITTER FROM OMNI TO HIGH-GAIN ANTENNA.
232	I+170.1H		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO A.
				3. START TRANSMITTING CURRENT TELEMETRY TO C.
233	I+176.3H		4	1. LOSS OF TRACK BY DSIF 4.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
234	I+180.1H		3	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
				3. START TRANSMITTING CURRENT TELEMETRY TO C.
			5	1. STOP TRANSMISSION OF TELEMETRY DATA.
235	I+181.5H		5	1. LOSS OF TRACK BY DSIF 5.
236	I+182H		3	1. TRANSMIT RTC-8 TO S/C.
			S/C	1. TURN ON CRUISE SCIENCE.
237	I+186.7H		4	1. REPORT ACQUISITION OF S/C TO A.

ITEM	TIME OF EVENT STANDARD	ACTUAL	STATION	EVENT
237	(CONTINUED)			2. START TRANSMITTING TRACKING DATA TO C.
238	I+190.7H		3	1. LOSS OF TRACK BY DSIF 3.
			4	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
239	I+194H		5	1. REPORT ACQUISITION OF S/C TO A.
				2. START TRANSMITTING TRACKING DATA TO C.
240	I+195.7H		4	1. STOP TRANSMISSION OF TELEMETRY DATA.
			5	1. START TRANSMITTING CURRENT TELEMETRY DATA TO C.
241	I+198.3H		4	1. LOSS OF TRACK BY DSIF 4.
242	I+201H		C	1. START COMPUTER PROGRAM TO DETERMINE TIMES FOR DSIF TRACKING AND TELEMETRY TRANSMISSION.
243	I+203H		C	1. COMPLETE COMPUTER PROGRAM FOR DSIF TRACKING AND TELEMETRY TRANSMISSION TIMES.
			A	1. THE SEQUENCE OF EVENTS FOR THE REMAINDER OF THE MISSION WILL BE COMPILED AT THIS TIME FROM THE RESULTS OF THIS PROGRAM.

D. TELEMETRY RECORDING SCHEDULE

Magnetic tape records will be made of all telemetry during the period each station is receiving a signal from the spacecraft. In addition to this recording which will be returned to JPL for subsequent analysis, certain selected functions will be recorded on oscillographs for "quick look" analysis. A telemetry to teletype encoder, in all stations except DSIF 0, converts the received telemetry data into a format suitable for TTY transmission. Telemetry recording conditions, e.g., demodulator in lock, will be reported in Station Reports (see Section V). The schedule for TTY transmission of telemetry data is presented in Table VII-3.

E. TRACKING DATA TRANSMISSION

Tracking data will be recorded at all times during the mission and will be transmitted in real time to JPL at the times specified in Table VII-2. DSIF stations, with the exception of DSIF 2, are capable of providing tracking data. DSIF 2 is equipped with a low-noise receiving system that does not have angle track capability.

TABLE VII-4. SCHEDULE OF REAL TIME TELEMETRY TRANSMISSION

Flight Day	DSIF Station	Start transmission of current data	Stop TTY Transmission	Amount of real time data transmitted	Remarks
1	0	L - 2 h	L - 5 m	75 m (nominal)	
	0	L - 5 m	L - 14 m	12 m	Loss of track at L + 7 m
	5	L + 30 m	L + 300 m	50-170 m*	*Station coverage varies with launch time & date
	4	L + 45 m*	L + 59 m	9 m (nominal	*Start data when station acquires
	4	L + 59 m	L + 7.4 h*	4 h (nominal)	Xmit all data recovered until loss of track
	5	L + 300 m	L + 360 m	37 m	
	5	L + 360 m	L + 480 m	75 m	
	5	L + 480 m	L + 600 m	75 m	
	5	L + 600 m	L + 760 m	100 m	
	3	L + 13 h	L + 23 h	10 h	Data by phone line
2	4	L + 23 h	L + 26.2 h	2 h	
	4	L + 26.5 h	L + 29.7 h	2 h	
	5	L + 30 h	L + 33.2 h	2 h	
	5	L + 33.5 h	L + 36.7 h	2 h	
	3	L + 37 h	L + 47 h	10 h	
3-6	4-5	Two 3.2 h transmissions per pass		4 h/day/station	
	3	10 h/pass in real time		10 h	
7	4	L + 166.5 h	L + 173 h	6.5 h	Earth acquisition
	5	L + 174 h	L + 181 h	7 h	
	3	L + 181 h	L + 191 h	10 h	Midcourse

TABLE VII-4. SCHEDULE OF REAL TIME TELEMETRY TRANSMISSION (Cont'd)

Flight Day	DSIF Station	Start transmission of current data	Stop TTY Transmission	Amount of real time data transmitted	Remarks
8	4	L + 191 h	L + 198 h	7 h	
	5	L + 198 h	L + 205 h	7 h	
	3	L + 205 h	L + 215 h	10 h	
9	4	L + 215 h	L + 222 h	7 h	
	5	L + 222 h	L + 229 h	7 h	
	3	L + 229 h	L +	10 h	End of full time coverage
10-E+1	All	All data transmitted in real time for each pass			

F. TRANSMISSION OF PREDICTION DATA

Prediction data will be supplied the DSIF initially from the Computing Facility at AMR (IPP) and subsequently from the Central Computing Facility (CCF) at JPL. The formats for these prediction data are given in Section V-A. The times at which the acquisition and prediction data will be supplied to the DSIF are given in Table VII-5.

TABLE VII-5. TRACKING DATA SAMPLING INTERVALS AND DOPPLER COUNT PERIODS

To be supplied with first addendum.

TABLE VII-6. ACQUISITION AND PREDICTION INFORMATION FOR THE DSIF

The times at which the acquisition and prediction information will be available for the DSIF are:

TIME	FROM	FOR DSIF	AMOUNT
L + 360 s	C	1, 4, 5	1 sample/min, I to I + 60 m
L + 715 s	IPP	1, 4, 5	1 sample/min, I to I + 60 m
I + 4 m	IPP	1, 4, 5	1 sample/min, I to I + 90 m
I + 60 m	C	1, 4, 5	1 sample/5 min, I to I + 4h
I + 180 m	C	1, 3, 4, 5	1 sample/5 min, I + 3 h to I + 30 h
I + 1 d	C	3, 4, 5	1 sample/5 min, I + 28 h to I + 54 h
I + 2 d	C	3, 4, 5	1 sample/5 min, I + 52 h to I + 78 h
I + 3 d	C	3, 4, 5	1 sample/5 min, I + 76 h to I + 102 h
I + 4 d	C	3, 4, 5	1 sample/5 min, I + 100 h to I + 126 h
I + 5 d	C	3, 4, 5	1 sample/5 min, I + 124 h to I + 150 h
I + 6 d	C	3, 4, 5	1 sample/5 min, I + 148 h to I + 174 h
I + 7 d	C	3, 4, 5	1 sample/5 min, I + 172 h to I + 198 h
I + 8 d	C	3, 4, 5	1 sample/5 min, I + 196 h to I + 222 h
I + 9 d	C	3, 4, 5	1 sample/5 min, I + 220 h to I + 246 h
I + 10 d (M + 1 d)	C	3, 4, 5	1 sample/5 min, I + 244 h to I + 270 h

TABLE VII-6. (Cont'd)

TIME FROM	FOR DSIF	AMOUNT
After M/C to E - 16 d		
1 d before tracking period	3, 4, 5	1 sample/5 min for complete pass
E - 15 d	3, 4, 5	1 sample/5 min for complete pass
E - 8 d	3, 4, 5	1 sample/5 min for complete pass
E	3, 4, 5	1 sample/5 min for complete pass
E + 1 d	3, 4, 5	1 sample/5 min for complete pass
After E + 1 d to End of Mission		
1 d before tracking period	3, 4, 5	1 sample/5 min for complete pass

APPENDIX A

RECORDING ASSIGNMENTS

A. LAUNCH STATION (STATION 0)

1. Magnetic Tape Recorder (Ampex FR-607) [1)]

Track	Type	Function	Range
1	Direct	Voice Label, Communications Interphone	
2	NRZ-PDM	Telemetry Word Sync	0 to -12 V
3	Direct	Mixer No. 3	
		1. Flutter Compensation Tone	
		2. 100 pps NASA Time Code on 1000 cps Carrier (1 Readout/Second)	
4	NRZ-PDM	Telemetry Bit Sync	0 to -12 V
5	FM	Raw Telemetry Data	±3 Volts pp
6	NRZ-PDM	Telemetry Binary Data	0 to -12 V
7	Direct	Mixer No. 2	
		1. Receiver Signal Strength, VCO Channel 6	0.5 V
		2. Amplitude Modulation, VCO Channel 7	0.5 V
		3. Reference Channel Static Phase Error, VCO Channel 5	0.5 V
		4. Reference Channel Dynamic Phase Error, VCO Channel 8	0.5 V
		5. Receiver In-Lock Relay, VCO Channel 4	0.5 V
		6. Transmitter Power, VCO Channel 3	
		7. Cape Timing, VCO Channel 1	0.5 V

Track	Type	Function	Range
		8. One-Way Doppler (Plus 5 kc Bias)	0.5 V
		9. 2 PPM NASA Time Code (On 100 cps Carrier) (1 Readout/Hour)	

1) Track assignments are in accordance with IRIG standard, but for the FR-607, the track designations are reversed for the IRIG standard (e.g., track 1 is the same as FR-607 track 7).

2. Ultra-Violet Oscillograph, 36 Channel Midwestern 603 Speed. 0.20 Inches/Second Before Launch. 2.0 Inches/Second After Launch.

Channel	Function	Range
1	Static Reference	
2	1 Readout/Minute Time Code	
3	1 Readout/Hour Time Code	
4		
5	Two-Way Doppler	
6	Doppler Switch Position	2 -3 V
7	Telemetry Word Sync	0 to -12 V
8	Telemetry Bit Sync	0 to -12 V
9	Reference Channel Static Phase Error	±3 V
10	Telemetry Binary Data	0 to -12 V
11		
12		
13		
14		
15	Static Reference	
16		
17	Receiver Signal Strength	±3.0
18		
19		
20		
21		

Channel	Function	Range
22		
23		
24	Reference Channel Dynamic Phase Error	±90°
25	Doppler Analog	
26	Receiver Acquisition Relay	0 to +3 V
27	Transmitter Switch Position	2 to 3 V
28		
29		
30		
31	Out Of Lock	0 to +3 V
32	Transmitter Power	0 to -1 V
33	Cape Timing	
34		
35	1 Readout 1 Per Minute Time Code	
36	Static Reference	

B. MOBILE TRACKING STATION (STATION 1)

1. Magnetic Tape Recorder (Ampex FR-107) [1)]

Track	Type	Function	Range
1	Direct	Voice Label, Command Line	
2	NRZ-PDM	Telemetry Word Sync	0 to -12 V
3	Direct	Timing Mixer 1. Flutter Compensation Tone 2. 100 pps NASA Time Code On 1000 cps Carrier (1 Readout/ Second) 3. 2 pps NASA Time Code on 100 cps Carrier (1 Readout/Minute)	
4	NRZ-PDM	Telemetry Bit Sync	0 to -12 V
5	FM	Raw Telemetry Data	±3 Volts pp

Track	Type	Function	Range
6	NRZ-PDM	Telemetry Binary Data	0 to -12 V
7	Ground Instru-mentation	Mixer 1	
		1. Static Error, VCO Channel 5	±3 V
		2. Signal Strength, VCO Channel 6	-90 dbm to -153 dbm
		3. Amplitude Modulation, VCO Channel 7	±3 db
		4. Reference Channel Dynamic Phase Error VCO Channel 8	±90°
		5. Acquisition Relay Signal VCO Channel 4	0 to +6 V

1) Track assignments are in accordance with IRIG Standard, but for the FR-107, the track designations are reversed from IRIG Standard (e.g., IRIG track 1 is the same as FR-107 track 7).

2. Ultra-Violet Oscillograph, 36 Channel Midwestern 603
   Speed. 0.15 Inches/Second

Channel	Function	Range
1	Static Reference	
2	1 Readout Per Minute Time Code	
3	Receiver Acquisition Relay	0 or +28 V
4	Receiver Reference Oscillator Mode Switch	
5	Antenna Mode Switch	0 to 28 V (Stairstep)
6	One-Way or Two-Way Doppler Mode Switch	0 or +28 V
7		
8		
9	Static Phase Error	±3 V
10		
11	RF Azimuth Error	±1°
12		
13	RF Elevation Error	±1°

Channel	Function	Range
14		
15	Static Reference	
16		
17	Signal Strength	-90 dbm to -153 dbm
18-19		
20	Amplitude Modulation	±3 db
21-23		
24	Dynamic Phase Error	±90°
25-27		
28	Telemetry Word Sync	0 to -12 V
29		
30		
31		
32	Transmitter Power	0 to 0.8 V
33-34		
35	1 pps Time Reference	
36	Static Reference	

C. PIONEER STATION (DSIF-2)

1. Magnetic Tape Recorder (Ampex (1) FR-107 and (1) FR-607)

Track	Type	Function	Range
1	Direct	Voice Label, Command Line	
2	NRZ-PDM	Telemetry Word Sync	0 to -12 V
3	Direct	Timing Mixer 1. Flutter Compensation Tone 2. 100 pps NASA Time Code on 1000 cps Carrier (1 Readout/Second) 3. 2 pps NASA Time Code on 100 cps Carrier (1 Readout/Minute)	

Track	Type	Function	Range
4	NRZ-PDM	Telemetry Bit Sync	0 to -12 V
5	FM	Raw Telemetry Data	±3 Volts pp
6	NRZ-PDM	Telemetry Binary Data	0 to -12 V
7	Ground Instru-mentation	Mixer 1	
		1. Static Phase Error, VCO Channel 5	±3 V
		2. Signal Strength, VCO Channel 6	-90 dbm to -153 dbm
		3. Amplitude Modulation, VCO Channel 7	
		4. Ref. Channel Dynamic Phase Error, VCO Channel 8	±90°
		5. Acquisition Relay Signal, VCO Channel 4	0 to +6 V

1) Track assignments are in accordance with IRIG Standard, but for the FR-107, the track designations are reversed from IRIG Standard (e.g., IRIG track 1 is the same as FR-107 track 7).

2. Ultra-Violet Oscillograph, 36 Channel Midwestern 603
Speed. 0.20 Inches/Second

Channel	Function	Range
1	Static Reference	
2	1 Readout Per Minute Time Code	
3	Receiver Acquisition Relay	0 or +6 V
4	Acquisition Switch Position	0 or +6 V
5	Antenna Mode Switch	0 to 28 V (Stairstep)
6		
7		
8		
9	Static Phase Error	±3 V
10		
11		
12		
13		

Channel	Function	Range
14		
15	Static Reference	
16		
17	Signal Strength (AGC)	-90 dbm to -153 dbm
18	Telemetry Word Sync	0 to -12 V
19		
20	Amplitude (Spin) Modulation	±3 db
21		
22		
23		
24	Dynamic Phase Error	±90°
25		
26		
27		
28		
29		
30		
31	Digital Hour Angle Error	±.176°
32		
33	Digital Declination Error	±.176°
34		
35		
36	Static Reference	

D. ECHO STATION (DSIF-3)

1. Magnetic Tape Recorder (Ampex (1) FR-107 and (1) FR-607) [1)]
   Two Machines. Speed. 3 3/4 Inches/Second

Track	Type	Function	Range
1	Direct	Voice Label, Command Line	
2	NRZ-PDM	Telemetry Word Sync	0 to -12 V
3	Direct	Timing Mixer	

Track	Type	Function	Range
		1. Flutter Compensation Tone	
		2. 100 pps NASA Time Code on 1000 cps Carrier (1 Readout/Second)	
		3. 2 pps NASA Time Code on 100 cps Carrier (1 Readout/Minute)	
4	NRZ-PDM	Telemetry Bit Sync	0 to -12 V
5	FM	Raw Telemetry Data	±3 Volts pp
6	NRZ-PDM	Telemetry Binary Data	0 to -12 V
7	Ground Instru-mentation	Mixer 1	
		1. Static Phase Error, VCO Channel 5	±3 V
		2. Signal Strength, VCO Channel 6	-90 dbm to -153 dbm
		3. Amplitude Modulation, VCO Channel 7	±3 db
		4. Ref. Channel Dynamic Phase Error VCO Channel 8	±90°
		5. Acquisition Relay Signal VCO Channel 4	0 to +6 V

1) Track assignments are in accordance with IRIG Standard, but for the RF-107, the track designations are reversed from IRIG Standard (e.g., IRIG track 1 is the same as FR-107 track 7).

2. Ultra-Violet Oscillograph, 36 Channel CEC 5-123
   Speed. 0.20 Inches/Second

Channel	Function	Range
1	Static Reference	
2	1 Readout Per Minute Time Code	
3	Receiver Acquisition Relay	0 or +6 V
4	Acquisition Switch Position	0 or +6 V
5	Antenna Mode Switch	0 to 28 V (Stairstep)
6		
7		

Channel	Function	Range
8		
9	Receiver Static Phase Error	±3 V
10		
11	RF Hour Angle Error	±0.1°
12		
13	RF Declination Error	±0.1°
14		
15	Static Reference	
16		
17	Receiver Signal Strength	-90 dbm to -153 dbm
18	Telemetry Word Sync	0 to -12 V
19		
20	Amplitude Modulation	±3 db
21		
22		
23		
24	Receiver Dynamic Phase Error	±90°
25-30		
31	Digital Hour Angle Error	+0.16°
32	Transmitter Forward Power	0 to 10 KW
33	Digital Declination Error	±0.16°
34		
35		
36	Static Reference	

E. JOHANNESBURG (DSIF-5)

1. Magnetic Tape Recorders (CEC 5-752) 1)
   Two Machines. Speed. 3 3/4 Inches/Second

Track	Type	Function	Range
1	Direct	Voice Label, Command Line	
2	NRZ-PDM	Telemetry Word Sync	0 to -12 V

Track	Type	Function	Range
3	Direct	Timing Mixer	
		1. Flutter Compensation Tone	
		2. 100 pps NASA Time Code on 1000 cps Carrier (1 Readout/Second)	
		3. 2 pps NASA Time Code on 100 cps Carrier (1 Readout/Minute)	
4	NRZ-PDM	Telemetry Bit Sync	0 to -12 V
5	FM	Raw Telemetry Data	±3 Volts pp
6	NRZ-PDM	Telemetry Binary Data	0 to -12 V
7	Ground Instru-mentation	Mixer 1	
		1. Static Phase Error, VCO Channel 5	±3 V
		2. Signal Strength, VCO Channel 6	-90 dbm to -135 dbm
		3. Amplitude Modulation, VCO Channel 7	±3 db
		4. Ref. Channel Dynamic Phase Error, VCO Channel 8	±90°
		5. Acquisition Relay Signal, VCO Channel 4	0 to +6 V

1) CEC 5-752 track assignments conform to IRIG Standard.

2. Ultra-Violet Oscillograph, 36 Channel CEC 5-123
   Speed. 0.20 Inches/Second

Channel	Function	Range
1	Static Reference	
2	1 Readout Per Minute Time Code	
3	Receiver Acquisition Relay	0 to +6 V
4	Acquisition Switch Position	0 to +6 V
5	Antenna Mode Switch	0 to 28 V (Stairstep)
6		
7		
8		

Channel	Function	Range
9	Receiver Static Phase Error	±3 V
10		
11	RF Hour Angle Error	±0.1°
12		
13	RF Declination Error	±0.1°
14		
15	Static Reference	
16		
17	Receiver Signal Strength	-90 dbm to -160 dbm
18	Telemetry Word Sync	
19		
20	Amplitude Modulation	±3 db
21		
22		
23		
24	Receiver Dynamic Phase Error	±90°
25		
26		
27		
28		
29		
30		
31		
32	Transmitter Forward Power	0 to 10 KW
33		
34		
35		
36	Static Reference	

F. WOOMERA (DSIF-4)

1. Magnetic Tape Recorder (CEC 5-752) [1)]
   Two Machines. Speed. 3 3/4 Inches/Second

Track	Type	Function	Range
1	Direct	Voice Label, Command Line	
2	NRZ-PDM	Telemetry Word Sync	0 to -12 V
3	Direct	Timing Mixer	
		1. Flutter Compensation Tone	
		2. 100 pps NASA Time Code on 1000 cps Carrier (1 Readout/Second)	
		3. 2 pps NASA Time Code on 100 cps Carrier (1 Readout/Minute)	
4	NRZ-PDM	Telemetry Bit Sync	0 to -12 V
5	FM	Raw Telemetry Data	±3 Volts pp
6	NRZ-PDM	Telemetry Binary Data	0 to -12 V
7	Ground Instru- mentation	Mixer 1	
		1. Static Phase Error, VCO Channel 5	±3 V
		2. Signal Strength, VCO Channel 6	-90 dbm to -153 dbm
		3. Amplitude Modulation, VCO Channel 8	±3 db
		4. Ref. Channel Dynamic Phase Error, VCO Channel 8	±90°
		5. Acquisition Relay Signal, VCO Channel 4	0 to +6 V

1) CEC 5-752 track assignments conform to the IRIG Standard

2. Ultra-Violet Oscillograph, 36 Channel CEC 5-123
Speed. 0.20 Inches/Second

Channel	Function	Range
1	Static Reference	
2	1 Readout Per Minute Time Code	
3	Receiver Acquisition Relay	0 to +6 V
4	Acquisition Switch Position	- to +6 V
5	Antenna Mode Switch	0 to 28 V
6		

Channel	Function	Range
7		
8		
9	Receiver Static Phase Error	±3 V
10		
11	RF Hour Angle Error	±0.1°
12		
13	RF Declination Error	±0.1°
14		
15	Static Reference	
16		
17	Receiver Signal Strength	-90 dbm to -160 dbm
18	Telemetry Word Sync	0 to -12 V
19		
20	Amplitude Modulation	±3 db
21		
22		
23		
24	Receiver Dynamic Phase Error	±90°
25		
26		
27		
28		
29		
30		
31		
32	Transmitter Forward Power	0 to 200 Watts
33		
34		
35		
36	Static Reference	

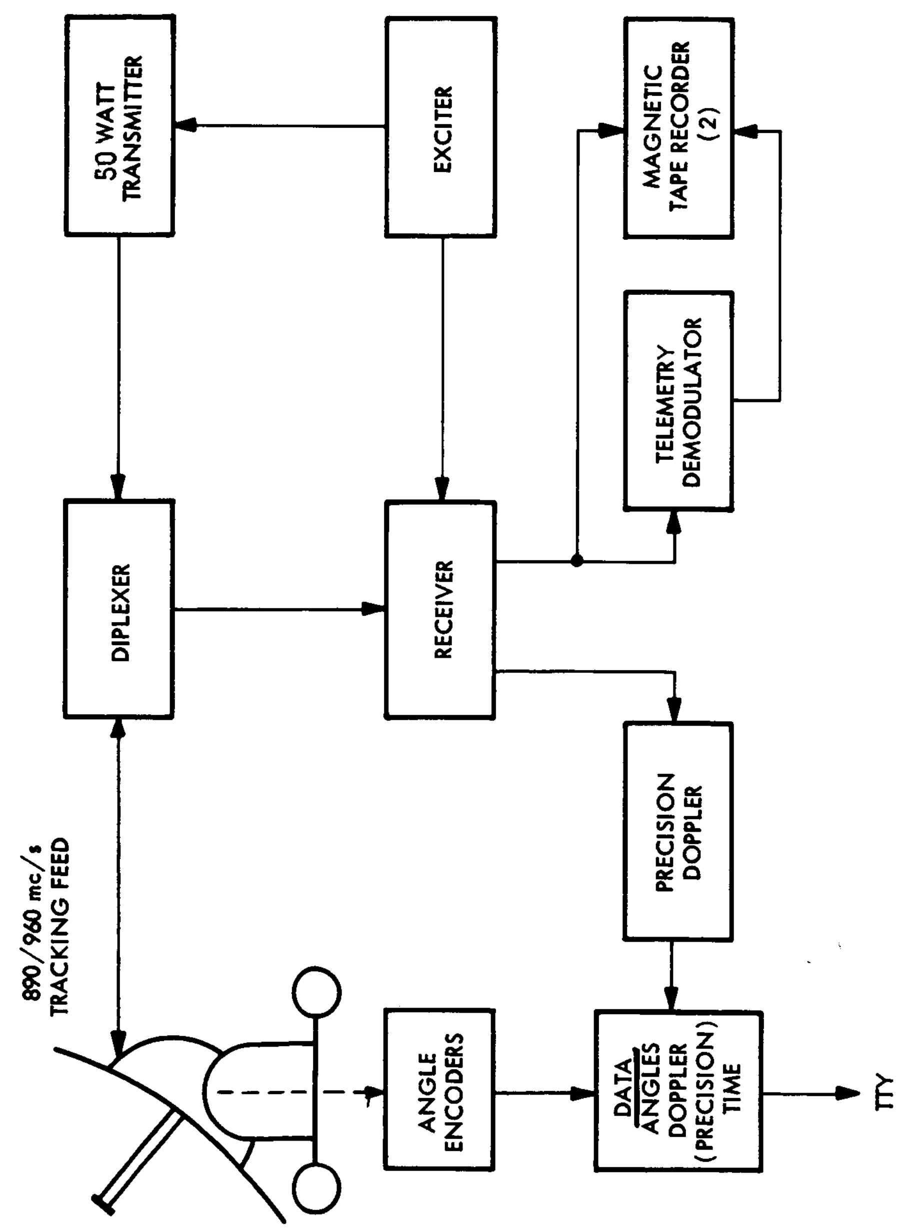


Figure B-1. Mobile Tracking Station (DSIF 1)

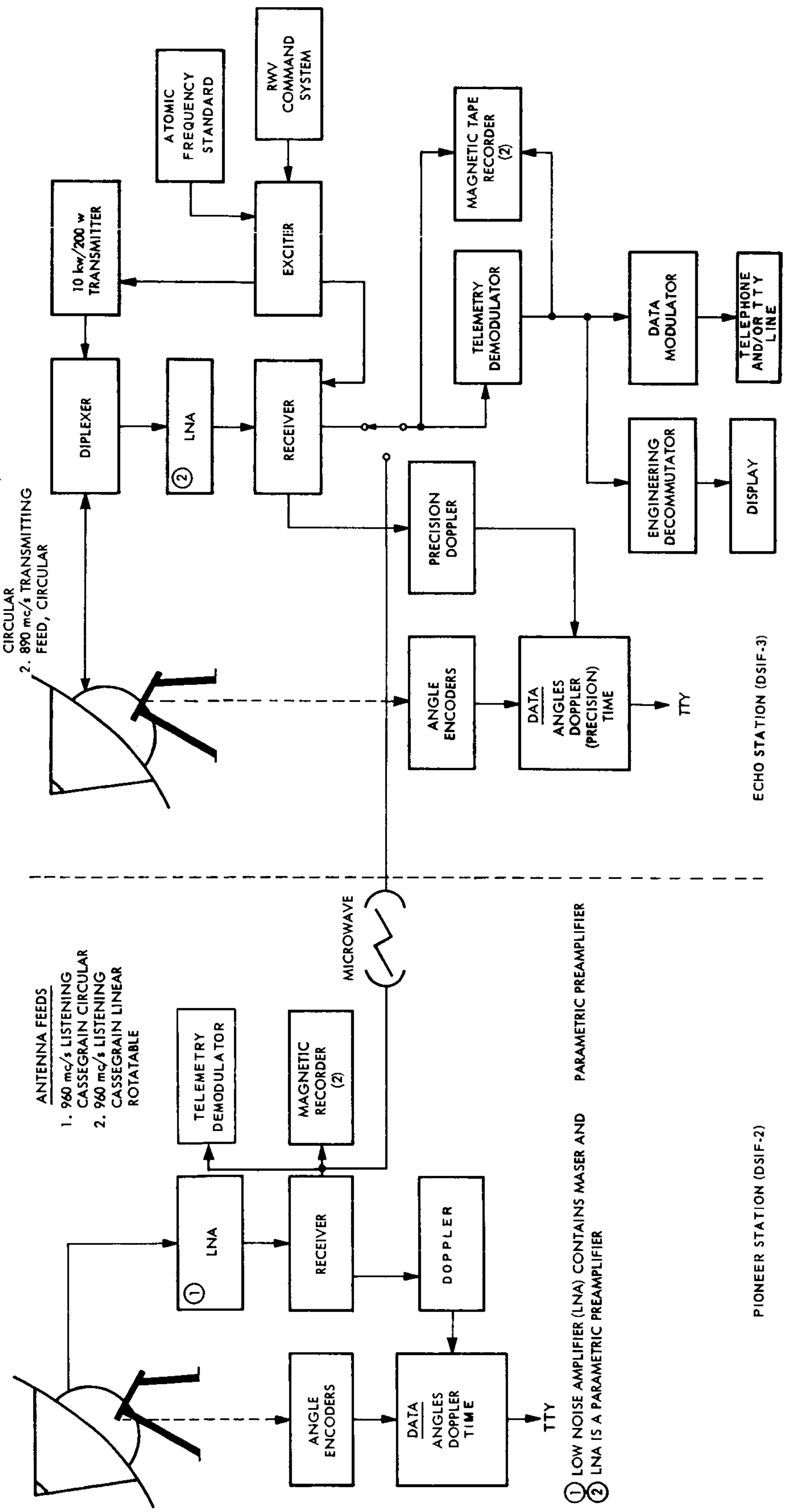
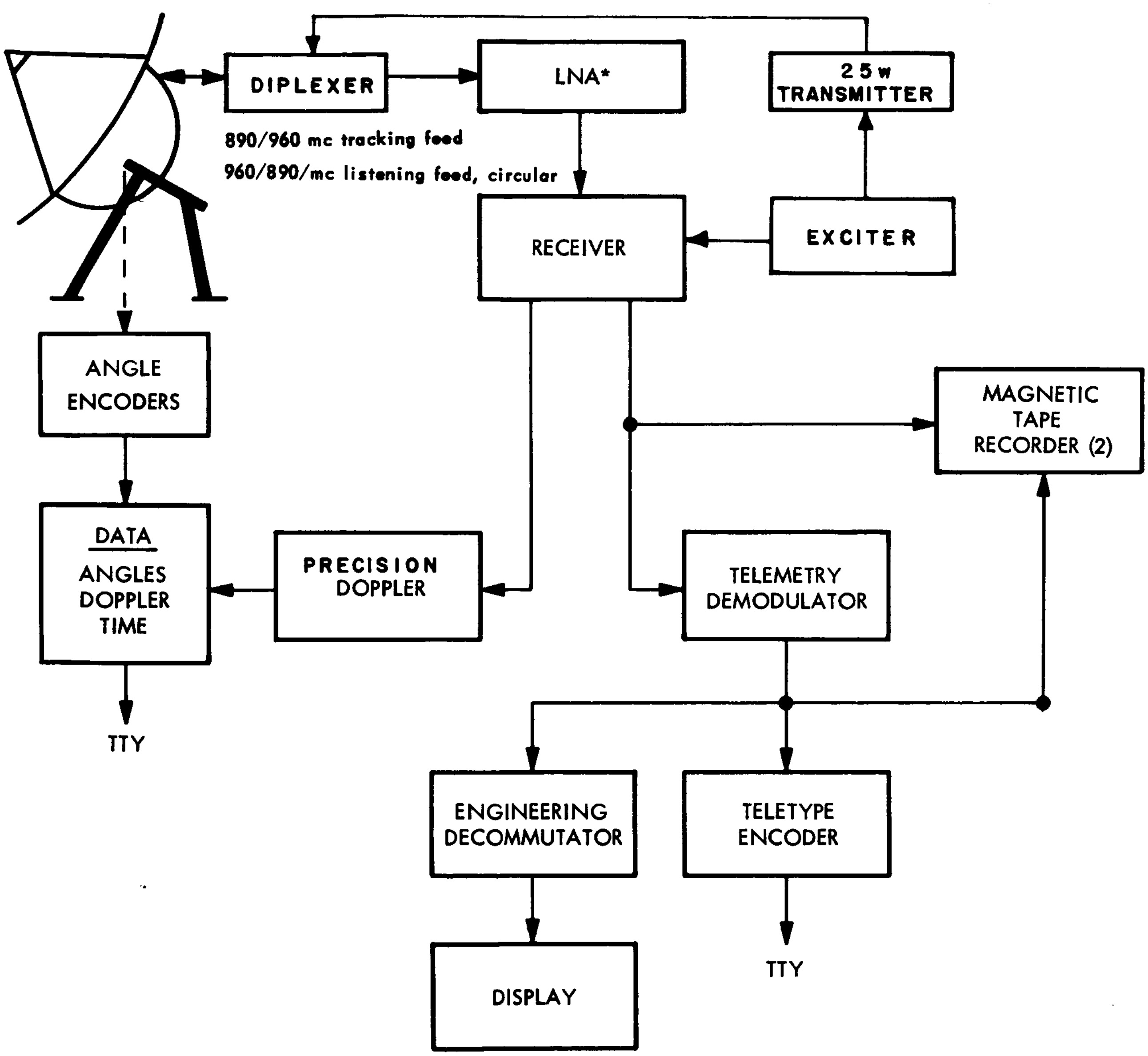


Figure B-2. Goldstone Stations (DSIF 2 and DSIF 3)



*Low Noise Amplifier (LNA) is a Parametric Preamplifier.

Figure B-3. Woomera Station (DSIF 4)

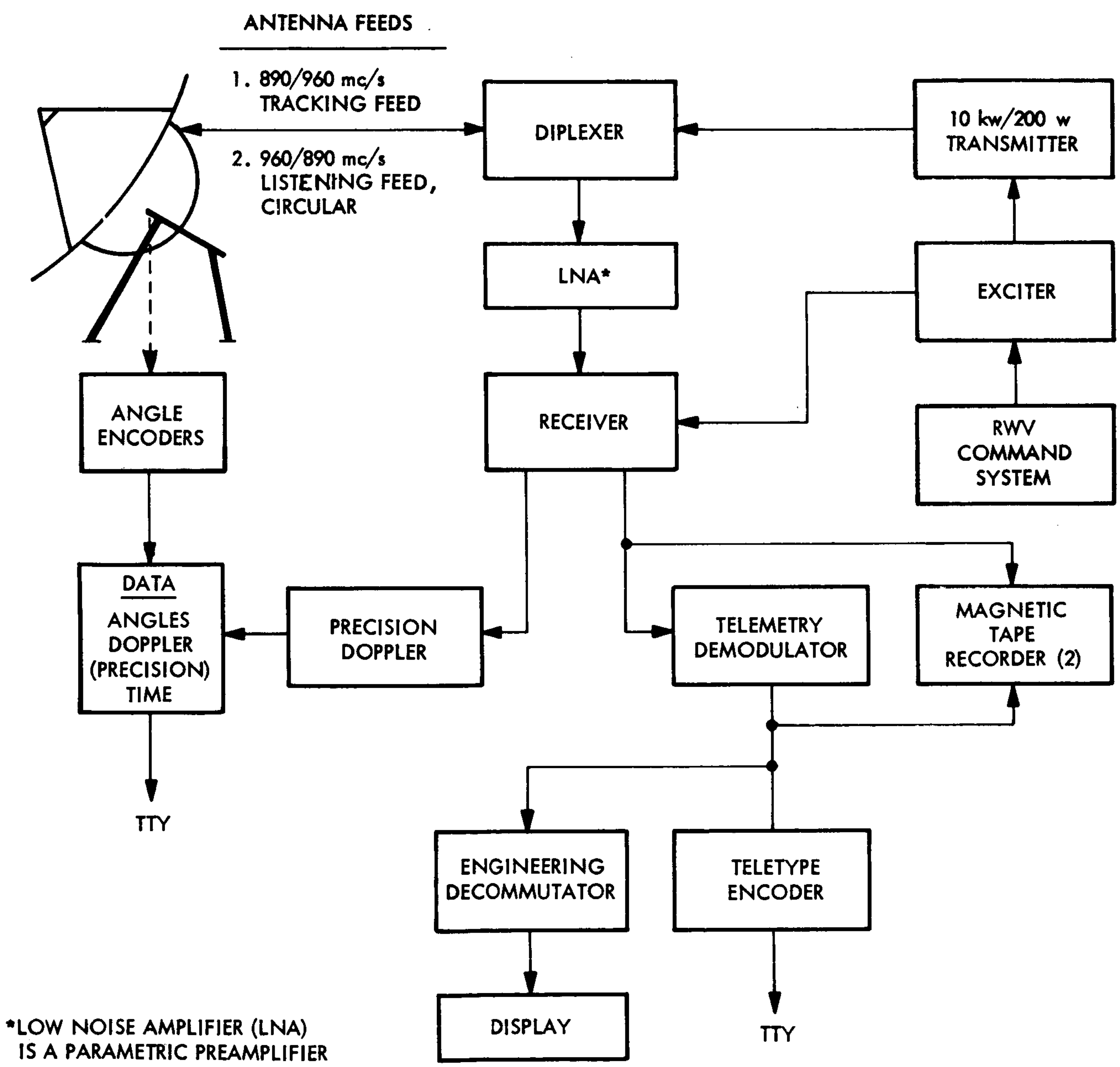


Figure B-4. Johannesburg Station (DSIF 5)

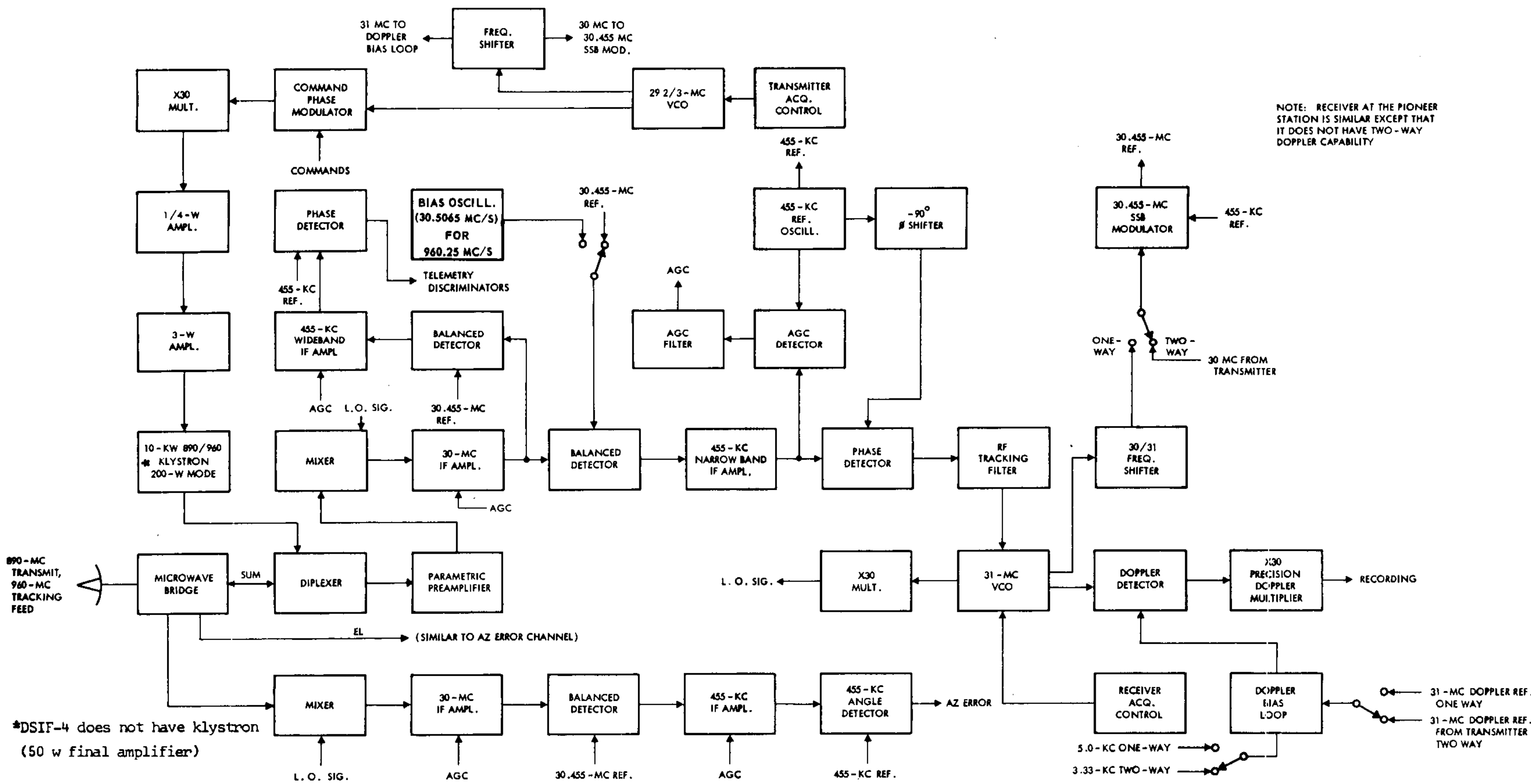


Figure B-5. Receiver and Transmitter Diagram Echo Station (DSIF 3), Woomera Station (DSIF 4), Johannesburg Station (DSIF 5)

TIM 332-15, MR

APPENDIX C

TELEMETRY CHANNEL ASSIGNMENTS

Telemetry channels (carrier frequency 960.05 or 960.1 mc/s)

CHANNEL NUMBER	DECOMM ADDRESS	MEASUREMENT	NORMAL APPROXIMATE TIME BETWEEN SAMPLES (SECS) Mode I	Mode II	Mode III
A0	00	Sync Word 1111111	4.3	37	NOT SAMPLED
A1	01	Deck C Signals	4.3	37	
A2	02	Battery Voltage	4.3	37	
A3	03	Yaw Control Gyro	4.3	37	
A4	04	Pitch Control Gyro	4.3	37	
A5	05	Roll Control Gyro	4.3	37	
A6	06	Battery Current Drain	4.3	37	
A7	07	Pitch Sun Sensor	4.3	37	
A8	08	Yaw Sun Sensor	4.3	37	
A9	09	Roll Error	4.3	37	
B0	10	Event Sequencer	4.3	37	
B1	11	Command Detector Monitor	4.3	37	
B2	12	Earth Brightness	4.3	37	
B3	13	Ant. Ref. Hinge Angle	4.3	37	
B4	14	Ant. Hinge Position	4.3	37	
B5	15	L-Band AGC (coarse)	4.3	37	
B6	16	L-Band Phase Error (coarse)	4.3	37	
B7	17	Propellant Tank Pressure	4.3	37	
B8	18	Battery Charger Current	4.3	37	
B9	19	* M/C Motor Nitrogen Pressure	4.3	37	
- -	20-23	Science Data	N/S	37	Sampled
C0	30	Sync Word 0000000	42.5	370	continuously during
C1	31	Deck D Signal	42.5	370	Mode III

* Midcourse

TIM 332-15, MR

CHANNEL NUMBER	DECOMM ADDRESS	MEASUREMENT	NORMAL APPROXIMATE TIME BETWEEN SAMPLES (SECS)		
			Mode I	Mode II	Mode III
C2	32	Deck E Signal	42.5	370	
C3	33	Deck F Signal	42.5	370	
C4	34	L-Band Phase Error (fine)	42.5	370	
C5	35	L-Band Directional Power	42.5	370	
C6	36	Louver Position	42.5	370	
C7	37	Spare	42.5	370	
C8	38	Spare	42.5	370	
C9	39	Spare	42.5	370	
D0	40	Sync Word 1111111	425	3700	
D1	41	Low Reference	425	3700	
D2	42	Solar Panel 4A 11 Voltage	425	3700	
D3	43	L-Band Omni Ant Power	425	3700	
D4	44	** A/C Nitrogen Pressure	425	3700	NOT SAMPLED
D5	45	Panel 4A 11 Current	425	3700	
D6	46	Spare	425	3700	
D7	47	Panel 4A 12 Voltage	425	3700	
D8	48	Panel 4A 12 Current	425	3700	
D9	49	High Reference	425	3700	
E0	50	Reference Temperature	425	3700	
E1	51	Booster Reg. Temp.	425	3700	
E2	52	* M/C Motor Nitrogen Tank Temp.	425	3700	
E3	53	Propellant Tank Temp.	425	3700	
E4	54	Earth Sensor Temp.	425	3700	
E5	55	Battery Temp.	425	3700	
E6	56	* A/C Nitrogen Temp.	425	3700	
E7	57	Panel 4A 11 Front Temp.	425	3700	
E8	58	Panel 4A 12 Front Temp.	425	3700	
E9	59	Panel 4A 11 Back Temp.	425	3700	

* Midcourse
** Attitude Control

TIM 332-15, MR

CHANNEL NUMBER	DECOMM ADDRESS	MEASUREMENT	NORMAL APPROXIMATE TIME BETWEEN SAMPLES (SECS) Mode I	Mode II	Mode III
F0	60	Electronic Assy. 1 Temp.	425	3700	NOT SAMPLED
F1	61	Electronic Assy. 2 Temp.	425	3700	
F2	62	Electronic Assy. 3 Temp.	425	3700	
F3	63	Electronic Assy. 4 Temp.	425	3700	
F4	64	Electronic Assy. 5 Temp.	425	3700	
F5	65	Lower Thermal Shield Temp.	425	3700	
F6	66	Upper Thermal Shield Temp.	425	3700	
F7	67	Plasma Electrometer Temp.	425	3700	
F8	68	Antenna Yoke Temp.	425	3700	
F9	69	Spare	425	3700	

APPENDIX D

SPACECRAFT SUBSYSTEMS

A. MARINER R ATTITUDE CONTROL SUBSYSTEM

As indicated by its designation, the function of the Attitude Control Subsystem is to control the orientation (attitude) of the spacecraft throughout the flight from the time of initiation of the "Sun Acquisition" command. There are essentially two normal modes of operation, one, a coasting mode, and two, a thrust mode. Transient periods exist while initially achieving the coasting mode and while shifting from one mode to the other. The Attitude Control Subsystem also measures the acceleration during the midcourse maneuver.

At time equal to launch plus 60 minutes, the Central Computer and Sequencer (CC&S) turns on the Attitude Control Subsystem, which then commences the sun acquisition procedure. Photoconductive elements placed strategically on the spacecraft sense the direction of the sun and cause actuation of cold nitrogen gas jets which rotate the spacecraft to align the roll axis along the sun-spacecraft line. Until launch plus 167 hours the spacecraft is maintained in this attitude but remains uncontrolled about the roll axis. At T + 167 h the photoelectric long-range earth sensor is activated and a roll search is executed which culminates in the spacecraft being stabilized about the roll axis such that the long-range earth sensor is pointed at the earth. This sensor is directly coupled to the high gain antenna which has been rotated to a preset angle. The spacecraft is now considered to be stabilized in the cruise mode.

During the maneuvers to this point, modules in the Attitude Control Subsystem which are active include: the control gyros and electronics in the rate configuration, the long-range earth sensor, the antenna drive servo system, the secondary and primary sun sensors and sun gate, the switching amplifier and logic, the celestial relay and logic, and the cold gas system.

During the seventh day of cruise, trajectory correction commands are transmitted to the spacecraft and stored in the CC&S and the midcourse maneuver is initiated. This requires that the accelerometer and gyros be turned on, the gyros connected in the inertial mode, and the earth sensor turned off. The cold gas system now rotates the spacecraft in roll and pitch to the precalculated angles stored in the CC&S, the autopilot is turned on, the transponder is switched from the high gain to the omniantenna, and the midcourse propulsion motor ignited and allowed to burn long enough to impart the velocity change required. During this thrust mode, the velocity change is measured by integrating the accelerometer output pulses, and the attitude is controlled by the jet vane actuators in the midcourse motor.

Following the midcourse burn the autopilot is turned off and the sun and earth are reacquired as in the original acquisition sequence. The spacecraft continues oriented in the cruise mode. 56.7 hours after encounter, the high-gain antenna is commanded to point at the sun and the mission is considered over.

B. MARINER R POWER SUBSYSTEM

The function of the Power Subsystem is to provide electrical energy to operate the equipment on board the spacecraft throughout the mission. Two primary sources are employed, a battery and two solar panels. The Power System provides regulation and conversion facilities so that dc, 400 cps sine wave, and 2400 cps square wave power are available to the users on separate busses.

In general, during the cruise mode when the spacecraft is oriented with the roll axis along the sun-spacecraft line the solar panels supply the electrical energy to operate the equipment. During midcourse maneuver, or at times when the power switching and logic circuit senses that the output of the solar panel is inadequate, the battery is switched into the system. Also during cruise mode, a portion of the output from the solar panels is taken by a battery charger circuit to automatically maintain the battery at full charge.

A booster regulator accepts the raw power output from the power switching and logic and regulates the dc to 52 volts. This regulated dc is in turn supplied to equipment requiring dc and also to the inverters which produce the 400 cps sine wave current, and the 2400 cps square wave current.

The outputs of the two inverters supply energy to the spacecraft equipment. The individual users of energy provide in their equipment, transformer-rectifier circuits to provide the proper voltages from the 2400 cps square wave. The 400 cps sine wave inverter produces three-phase power to run the gyros when they are operating. During the cruise mode the inverter is switched to produce only single phase 26 volt sine wave.

The basic timing signal from which the alternating outputs are derived is provided by the CC&S in the form of a 38.4 kcps square wave signal. Dividing circuits in the power supply synchronizer supply provide the frequency reference for the 400 and 2400 cps inverters.

C. MARINER R CENTRAL COMPUTER AND SEQUENCER

The Central Computer and Sequencer (CC&S) supplies the timing, sequencing, and computational services for the other subsystems on the spacecraft. As inputs, the CC&S is able to accommodate preset sequences and event times, decoded transmitted "execute" commands, quantitative decoded transmitted commands and the accelerometer output. The CC&S outputs actuate spacecraft functions as required by these inputs.

The outputs of the CC&S can be classified in several groupings, viz, launch sequence, propulsion sequence, encounter sequencer, and cyclics.

The launch sequence controls all spacecraft events from launch until cruise mode is established. This sequence is initiated three minutes prior to launch. To insure the correspondence of lift-off time and CC&S time an inhibit capability exists in the blockhouse that will hold CC&S time during countdown holds occurring subsequent to initiation of the launch sequence.

The propulsion sequence contains the sequence of events necessary to perform the midcourse maneuver. This sequence is initiated by a real time radio command and involves nine events, three of which are set by radio command prior to initiation. The three set by radio command are roll duration, pitch duration, and velocity increment. The CC&S integrates the output from the pulse rebalanced accelerometer in the Attitude Control Subsystem to measure the actual velocity increment.

The encounter sequence contains two events, start encounter mode, and stop encounter mode, which are given in the vicinity of the planet. This sequence has redundant start and stop commands, either by the CC&S or by a real time radio command.

A central clock provides a means of timing within all of the sequences, and also is used as a basis for the derivation of the cyclic signals. The cyclic outputs include the 38.4 kcps square wave to the power system, the hinge reference angle update every 16.7 hours, and the science timing pulse every 16.7 hours.

D. RF COMMUNICATION SYSTEM

The RF Communication System (Fig. D-1) consists of a 3-watt transponder RF amplifier and an "L" band RF diplexer. The 890/960 mc/s transponder operates through either the omnidirectional antenna or the directional high-gain parabolic antenna. The transponder system consists of an automatic phase tracking receiver operating at 890 mc/s and an integrally related transmitter operating at 960.05 or 960.10 mc/s. Except for the vacuum tube cavity amplifiers in the transmitter, the transponding elements are solid state devices. The 5 mw output signal of the solid state portion is amplified to 3-watts in two vacuum tube cavity amplifiers operating in cascade.

The transmitter is arranged to feed either the omnidirectional or the directional high gain antenna. This is accomplished by driving the first cavity amplifier (250 mw) from the solid state output and then driving either of two

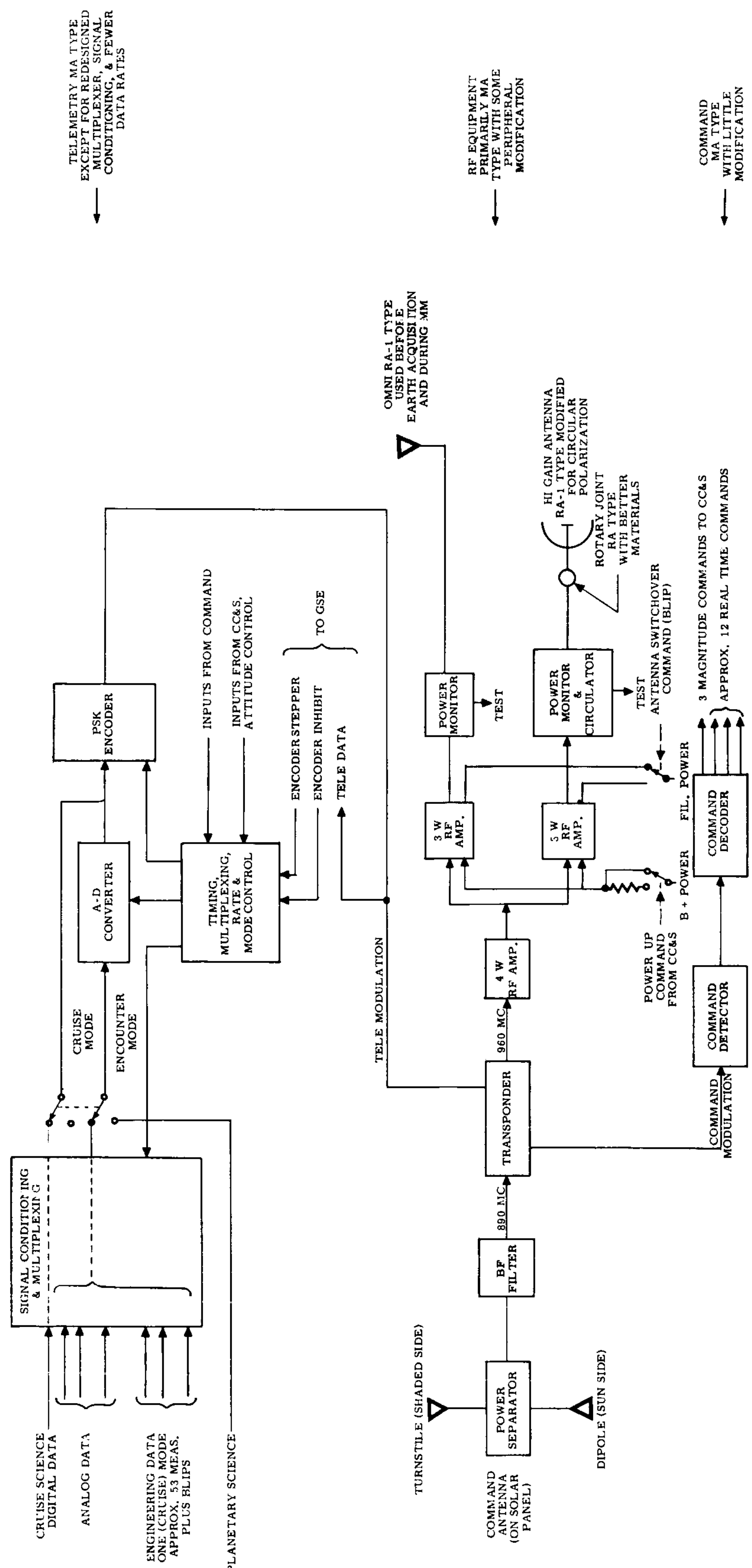


Figure D-1. RF Communications System Block Diagram

3-watt cavity amplifiers from the output of the 250 mw cavity amplifier. Only one of the 3-watt cavity amplifiers shall be operated during a period of time as selected by ground and/or attitude control command.

The transponder shall have two modes of operation:

1) Non-coherent
2) Coherent

The non-coherent mode will be used when the transponder is not receiving a signal from the earth. Under this condition, the transmitter is driven from a crystal oscillator which provides a stable signal source for the S/C-to-earth link.

The coherent mode is selected automatically whenever the transponder receiver locks to an incoming signal. A transfer switch,which is controlled by the coherent AGC system, will bias off the crystal oscillator and at the same time switch the VCO output signal to the transmitter multiplier chain. The coherent mode provides a completely coherent system whereby the phase and frequency of the S/C transmitted signal is integrally related to that of the incoming signal by the ratio of 96/89.

E. SPACECRAFT TELEMETRY SUBSYSTEM

The Spacecraft Telemetry Subsystem is basically a digital system which bi-phase modulates sine wave subcarriers, which in turn modulate the RF transponder. The basic functions are described as follows:

1) Accepts approximately 50 analog and digital signals from the S/C.
2) Accepts and keeps a cumulative count of an unspecified number of uncorrelated event pulses from the S/C.
3) Conditions and encodes the foregoing signals to a common 7 bit digital format.
4) Adds unique codes into the data to identify the end of sequential frames and sub-frames of commutated data.
5) Time sequentially bi-phase modulates a sine wave subcarrier with the 7 bit data words.

6) Generates a 63 bit pseudo-noise (PN) code sequence which is synchronous with the data.
7) Bi-phase modulates a square wave sync subcarrier with the PN code from (6).
8) Linearly mixes and conditions the subcarriers as described in (5) and (7) to suitably modulate the RF transponder.
9) Provides change of rate of data encoding to provide an increased bandwidth in the RF communications system to planetary distances.

The telemetry system has the following three data modes:

1) Launch Mode: Each data frame consists of only engineering data samples. This mode is employed from prelaunch to earth acquisition.
2) Cruise Mode: Each data frame consists of both engineering and scientific data samples. This mode is used during the period from earth acquisition to termination of the mission except for the period specified at planetary encounter.
3) Encounter Mode: Each data frame consists of only scientific data samples. This mode is employed from encounter minus 1 day to encounter plus 1 day.

The telemetry system is capable of operating at two transmission rates, 33.3 bits per sec (bps) and 8.33 bps. The 33.3 bps is used during launch check-out and for the period from launch to earth acquisition. The 8.33 bps is used for the period from earth acquisition to end of mission. At earth acquisition the transfer from 33.3 bps to 8.33 bps is automatically commanded by a signal from the attitude control system. The rates can also be selected by real time ground commands.

F. SPACECRAFT COMMAND SUBSYSTEM

The Spacecraft Command Subsystem performs the following functions:

1) Detects commands in the form of binary PSK modulation on an audio frequency subcarrier, which is the output of the S/C radio subsystem demodulator.
2) Decodes the digital commands, routing real time commands to recipient S/C subsystems, and stored commands to the CC&S for the midcourse maneuver.

Two modulated subcarrier signals are transmitted to the S/C and are recovered in the S/C radio receiver. One of the subcarriers is modulated by a pseudo noise (PN) sync code and the other subcarrier is modulated by command bits. The two modulated subcarrier signals from the S/C radio receiver are applied to the input of the command detector. The command bits and sync code are recovered and applied to the command decoder. The decoder determines which command has been sent and issues an output to the designated S/C subsystem. There are two types of commands:

1) Real Time Commands - Commands which result in a single momentary closure of a solid state switch.
2) Stored Commands - Commands which result in the transfer of an 18 bit serial binary word to the command user.

A standard command word comprises 26 serial bits. The first bit, a binary "one", acts as a framing bit. The second bit, carried only to maintain compatibility with existing equipment, is always a binary "zero". The next 6 bits form the command address block, and the final 18 bits form the data block. The magnitude block contains the CC&S internal address plus the magnitude and polarity of the stored commands. The command address completely identifies which command has been sent. Although the data block contains no information in the case Real Time Commands, those digits are transmitted as binary "zeros" to maintain the standard command word format. All words are transmitted at a rate of 1 bit/sec.

G. DATA CONDITIONING SUBSYSTEM (DCS)

The Data Conditioning Subsystem performs the following four basic functions for the scientific instrumentation on Mariner R.

1) Analog to digital conversion
2) Digital to digital conversion (parallel to serial)
3) Sampling timing
4) Planetary acquisition

The transformed data is loaded into an eight-stage counter shift register which is the location of the data handling section of the DCS. This register acts as a counter for analog digital conversions, a PN generator for sub-framing and framing the data, buffer storage for the digital to digital conversion and the comparator for the planetary acquisition function. The data shift out is controlled by the telemetry data encoder in synchronism with the data encoder format. The timing functions are generated by a binary clock and associated matrix which is driven by the bit sync pulse from the data encoder. A second timing function for long intervals (200 hours), is generated internally from a 1 per 15.7 hours pulse.

APPENDIX E

SCIENTIFIC EXPERIMENTS

The scientific experiments for this mission are divided into four principal categories, Radiometer, Infrared, Magnetometer, and Particles and Radiation, and are described in the following paragraphs.

A. RADIOMETER EXPERIMENT

The purpose of this experiment is to obtain information which will assist in the determination of the nature of the atmosphere of Venus and the role that it plays in the radiation balance of the planet. It is hoped to obtain information on the temperature and possibly the nature of the Cytherean surface. The composition of the atmosphere and in particular the presence of water vapor below the cloud layer may also be determined. The microwave brightness temperature is neasured at two wavelengths and the phenomena investigated are selective absorption, limb brightening, and phase effect.

A single antenna will share the two wavelengths of 13.5 and 19.0 mm. The antenna will be mounted with its axis perpendicular to the roll axis of the spacecraft and will be moved so as to scan a sector 60 degrees above and 60 degrees below a plane parallel to the ecliptic. This scan will begin 24 hours prior to planetary encounter at an angular rate of 1 degree per second. As the spacecraft moves by the planet at encounter, a limb of the planet will first be intercepted by the plane of the antenna scan. At this time the scan rate will automatically be reduced to 0.1 degree per second, and will continue until the antenna axis is 5 degrees off of the planetary limb. The scan will then reverse its direction and another chord of the planetary disk will be scanned. Again when the 5 degree off the limb position is reached, reversal occurs and the operation is repeated. Thus, an approximately sinusoidal path of one or more periods is scanned across the disk of the planet. If the planet is lost during any part of this scan, the scan rate and amplitude automatically returns to the initial mode until the planet is again acquired, whereupon the lower scan rate takes over.

The receiver is of the crystal video type with an rms noise fluctuation of 5 degrees K on the 13.5 mm wavelength band, and 8 degrees K on the 19 mm band. The over-all accuracy is of the order of magnitude of ±1.0 percent at 600 degrees K. The integration time of the instrument is 20 seconds, and the antenna beam width does not exceed 2.4 degrees.

B. INFRARED EXPERIMENT

This experiment, in conjunction with the radiometer experiment, will result in a fairly complete radiation picture of the planet. The existence of fine structure of the cloud layer may be determined, which if of sufficient dimensions, will allow observations to be made through to lower levels, or possibly even to the Cytherean surface. The selection of wavelengths will be such as to give information as to atmospheric composition.

The instrument will be rigidly attached to the radiometer package with the optical axis of the infrared instrument parallel to that of the radiometer antenna. Through the use of interference filters, two wavelength regions will be utilized, 8 to 9 microns, and 10 to 10.5 microns. The optical system has a speed of f/2.6 and a focal length of 7.8 cm, with a total angular field of view of 1 degree. A thermistor bolometer is used as a detector with a sensitivity of about 2 degrees K for the noise equivalent temperature.

C. MAGNETOMETER EXPERIMENT

This experiment will enable a determination to be made of the three mutually perpendicular components of the magnetic field in the interplanetary space between the Earth and Venus, and in the vicinity of Venus at planetary encounter. If the planet has a magnetic field of the same order of magnitude as that of the Earth, its existence will definitely be determined. However, if the Cytherean magnetic field is extremely small, whether or not it is detected will be a function of the encounter distance. For this reason, a trajectory which will allow the closest approach is desired.

The instrument is of the fluxgate type with the sensor depermed and degaussed from the magnetic effects of the spacecraft. It will make measurements over two ranges: 0 to ± 64 gamma, and 0 to ± 640 gamma. Sensitivity is such that changes in any of the three magnetic field components of the order of magnitude of 0.5 gamma can be detected.

D. PARTICLES AND RADIATION

1. Charged Particle Experiment

This experiment consists of an ionization chamber and several Geiger-Mueller counters. Both instruments detect the presence of electrically charged particles by the ionization they produce in a gas surrounding a charged collector. Information as to the temporal and spatial distribution of these particles, as well as their variations and energies, is of great importance in the understanding of the nature of cosmic radiation and of the trapped particle regions which are known to surround the earth, and which are suspected to exist at the planets.

An ionization chamber of the Neher type will be utilized to detect the presence of protons above 10 Mev energies, and of electrons above about 0.4 Mev. Its dynamic range is considerable, from several instrument counts per hour to several per second.

Two Geiger-Mueller counters, type RCL 10311, will be utilized to count alpha particles above 40 Mev in energy, protons above 10 Mev, and electrons above about 1 Mev. One of these counters will be shielded with a gold-plated, steel envelope, and the other with a beryllium envelope. This allows a discrimination between protons and electrons. Their counting rate lies between about 20 per second for the cosmic ray background, and 10,000 per second.

One Anton type 213 will be utilized to cover a lower particle energy range, and will count protons above 0.5 Mev in energy, and electrons above 35 Kev. Here, the counting rate lies between 0.2 counts per second for the cosmic ray background and 20,000 per second.

2. Plasma Experiment

This experiment is designed to obtain information on the extent, variations in, and mechanism of the solar corona. To fully exploit this experiment, the results must be carefully correlated with those from the magnetometer experiment, and with the solar phenomena observed on Earth. This information is of extreme importance in our understanding of the dynamics of stellar bodies, and of the regions about them.

A curved plate particle spectrometer of JPL design will be utilized to detect the energy flux of solar protons. It has a 10 degree angular aperture and will be located on the spacecraft so as to look in a direction parallel to the roll axis. Since the spacecraft will be oriented so that this axis is always pointing toward the sun, this assures that the spectrometer will be oriented at all times in this direction. The instrument will measure the flux at 10 energy levels, from 250 ev to 8400 ev. The current ranges which are measured are from 10^{-6} to 10^{-13} amperes.

3. Micrometeorite Experiment

The purpose of this experiment is to measure the temporal density of cosmic dust particles which exist in interplanetary space and in the region about the planets. Information gained from this experiment will be useful in formulating the history and dynamics of evolution of the solar system.

A momentum type experiment is planned, utilizing a crystal microphone fastened to an impact plate, which is fixed with respect to the spacecraft. The plate is positioned so that its plane is roughly perpendicular to the direction of motion of the Earth in its orbit. Two levels of particle mass detection are utilized, with lower limits of 10^{-7} and 10^{-8} grams. All particles above this mass limit, with components of momentum perpendicular to the plate greater than 10^{-4} dyne-seconds will be detected. The microphone circuitry will allow a counting rate of 50 per second, but since this is far above the expected rate, the two counting levels are each connected to a 2-stage binary counter. Each counter is reset approximately every 36 seconds.

E. OPERATING PERIODS

All instruments except the radiometer and infrared detector will be operated during the entire flight. The radiometer and infrared experiments will operate during the encounter part of the flight. The data will be transmitted in real time.

APPENDIX F

RECEIVED FREQUENCY EQUATIONS

The equations relating the received frequency, the frequency transmitted from the spacecraft, the doppler shift and the receiver VCO frequencies are given below:

1. Definition of Symbols

f_{RC} = Received frequency

f_t = Spacecraft transmitted frequency.

v = Radial velocity component. v_1 S/C to DSIF station. V_2 DSIF station to S/C.

c = The speed of light.

$(1 \pm \frac{v_1}{c})$ = Doppler term, S/C to DSIF station.

$(1 \pm \frac{v_2}{c})$ = Doppler term DSIF Station to S/C.

f_v = Receiver 31 mc/s VCO frequency.

f_R = Transmitter 29.66 mc/s VCO frequency.

f_1 = 30.5065 mc/s bias oscillator frequency.

f_2 = 455 kc/s oscillator frequency (0.455 mc/s).

2. For DSIF-1.

a. One-way transponder tracking at 960.05 and 960.1 mc/s.

$$f_{RC} = f_t(1 \pm \frac{v_1}{c}) \tag{1}$$

$$f_{RC} = 30 f_v + \frac{30}{29\ 2/3} f_R \tag{2}$$

$$\therefore f_t(1 \pm \frac{v_1}{c}) = 30 f_v + \frac{30}{29\ 2/3} f_R \tag{3}$$

b. Two-way transponder tracking at 960.05 and 960.1 mc/s.

$$f_{RC} = f_t\,(1 \pm \frac{v_1}{c}) = 30\,f_v + \frac{30}{29\ 2/3}\,f_R \tag{4}$$

$$f_t = \frac{32}{29\ 2/3}\ 30\,f_R\,(1 \pm \frac{v_2}{c}) \tag{5}$$

$$\text{assume } v_1 = v_2,\ \text{then} \left(1 \pm \frac{v}{c}\right)^2 \simeq (1 \pm \frac{2v}{c}) \tag{6}$$

$$\text{and } f_v = \frac{f_R}{29\ 2/3}\left[31 - 32\,(\frac{2v}{c})\right] \tag{7}$$

c. Pseudo two-way transponder tracking at 960.05 and 960.1 mc/s with DSIF-3 or DSIF-5 transmitting.

$$f_{RC} = f_t\,(1 \pm \frac{v_1}{c}) = 30\,f_v + \frac{30}{29\ 2/3}\,f_{R_1} \tag{8}$$

$$f_t = 30\,f_{R_2}\,(1 \pm \frac{v_2}{c})\,\frac{32}{29\ 2/3} \tag{9}$$

where f_{R_2} = the transmitter VCO frequency of DSIF-3 or DSIF-5, then,

$$\frac{32}{29\ 2/3}\,f_{R_2}\,(1 \pm \frac{v_1}{c} \pm \frac{v_2}{c}) = f_v + \frac{f_{R_1}}{29\ 2/3} \tag{10}$$

3. For DSIF-2

a. One-way transponder tracking at 960.05 and 960.1 mc/s.

$$f_{RC} = f_t\,(1 \pm \frac{v}{c}) = \frac{960}{31}\,f_v \tag{11}$$

b. Pseudo two-way transponder tracking at 960.5 and 960.1 mc/s.

$$f_{RC} = f_c \left(1 \pm \frac{v_1}{c}\right) = \frac{960}{31} f_v \tag{12}$$

$$f_t = \frac{32}{29\ 2/3}\ 30\ f_{R_2}\ \left(1 \pm \frac{v_2}{c}\right) \tag{13}$$

Then,

$$\frac{32}{29\ 2/3}\ f_{R_2}\ \left(1 \pm \frac{v_1}{c} \pm \frac{v_2}{c}\right) = \frac{32}{}\ f_v \tag{14}$$

Where, f_{R_2} = DSIF station transmitter VCO frequency

c. One-way off frequency[1)] tracking at 960.1 mc/s.

$$f_{RC} = f_t \left(1 \pm \frac{v_1}{c}\right) = 30 f_v + f_m \tag{15}$$

$$f_m = f_1 - f_2 \tag{16}$$

Then,

$$f_{RC} = 30\ f_v + f_1 - f_2 \tag{17}$$

4. For DSIF-3 and DSIF-5.

a. One-way transponder tracking at 960.05 and 960.1 mc/s.

$$f_{RC} = f_t \left(1 \pm \frac{v}{c}\right) = \frac{960}{31} f_v \tag{18}$$

b. Two-way transponder tracking at 960.05 and 960.1 mc/s.

$$f_{RC} = f_t \left(1 + \frac{v}{c}\right) = 30\ f_v + \frac{30}{29\ 2/3}\ f_R \tag{19}$$

$$f_t = \frac{32}{29\ 2/3}\ 30 f_R \left(1 \pm \frac{v}{c}\right) \tag{20}$$

Assume $v_1 = v_2$ then, (21)

1) "off frequency" is defined as that mode of operation in which the 2nd L. O. frequency shifter loop is replaced by a fixed oscillator.

$$(1 \pm \frac{v}{c}) \simeq (1 \pm \frac{2v}{c}) \qquad (22)$$

$$\text{and } f_v = \frac{f_R}{29\ 2/3} \left[31 - 32\left(\frac{2v}{c}\right)\right] \qquad (23)$$

c. One-way capsule tracking at 960.1 mc/s.

$$f_{RC} = f_t (1 \pm \frac{v}{c}) = 30 f_v + f_m \qquad (24)$$

$$f_m = f_1 - f_2 \qquad (25)$$

Then,

$$f_{RC} = 30 f_v + f_1 - f_2 \qquad (26)$$